TOBER, 1944 ONE SHILLING & SIXPENCE

Plastics

ALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

PUBLIC LIBRARY
NOV 1 1944
DETROIT

for
PLASTIC
MOULDINGS
De La Rue Plastics Ltd

for
INSULATING
BOARDS
Sleevings and Connecting Wires
De La Rue Insulation Ltd

Telephone: Regent 2901
IMPERIAL HOUSE · REGENT STREET · LONDON · W·1

Elmdon

Synthetic resin laminated material

Paper base and fabric base in sheets

panels or machined shapes

Available in all grades

We welcome your Orders and Enquiries

East London Mica Works

Walthamstow, London, E.17

SPECIAL TOOLS *for* MACHINING PLASTICS

It is important that keen cutting edges be maintained.

FIRTH-BROWN "MITIA" CARBIDE

Tools tipped with FIRTH-BROWN "MITIA" CARBIDE resist the abrasive action encountered in the machining of many plastics and laminated materials.

FIRTH-BROWN "MITIA" CARBIDE

Saws tipped with "MITIA" CARBIDE give the desired finish at high speeds.

FIRTH BROWN

THOS FIRTH & JOHN BROWN LTD SHEFFIELD

BRITISH HOMOPHONE

Turnover Increase

Sir Herbert Morgan's Speech

The annual general meeting of the British Homophone Co. Ltd. was held on Thursday, September 28th, in London.

Sir HERBERT MORGAN, K.B.E., the chairman, in the course of his speech, said: The net profit for the year amounted to £12,187 before charging taxation; this compares with £11,568 earned in the previous year. There is a considerable increase in the charge for taxation, which amounts to £4,600 as against £1,650. The result is that the final net profit amounts to £7,587, against £9,918. Our wholly owned subsidiary, Ebonestos Industries Ltd., shows for the period to March 31, 1944, a net profit of £31,433 before taxation, compared with £25,574. The combined net profits of the two companies amount to £9,020, against £19,030. Before allowing for E.P.T. and income tax the profits were £43,620, against £37,142. These figures demonstrate how severely our net earnings are restricted by E.P.T.

At March 31, 1944, the fixed assets of Ebonestos Industries Ltd. amounted to £63,991, while the net amount of the floating assets was £77,587, or a total of £141,578. The turnover of both companies has considerably increased, which is one of the best proofs of the service we render to our customers. During the current year the business has been well maintained, and at the moment we may say that our order book is full. It must be apparent, however, that the time is approaching when there will be a falling off in plastic work used for war work. Your directors are fully alive to the necessity of planning so that the change-over from war to peace production can be effected in the shortest possible time.

FUTURE OF PLASTICS

There is evidence that the plastics industry will play a full share in supplying the materials wanted in the coming years, but one must emphasise that for post-war requirements competition will be keen. There are many newcomers to the industry, and I only hope that reckless price-cutting may be avoided.

So far as this company is concerned, it must be quite clear to all that so long as E.P.T. remains there can be no hope of increased dividends. The actual profits earned by the company, as indicating possibilities of dividends in the future, must be considered together with the fact that there has been in the past few years a steady and even flow of orders at fair prices, which are the best conditions for a manufacturing business.

With intelligent planning, not only by the Government but by ourselves, let us hope that these conditions will be maintained. Such time as can be spared from the responsibilities of war work, our technical staff are devoting to exploring fresh channels of production and research work of various kinds.

Again I have to thank Mr. Jack Lesser on your behalf. He has proved himself to be resourceful, enterprising and courageous in the many problems that he has had to deal with. To the whole of our executive and workers we would like to extend our appreciation for their maintaining, in the fifth year of the war, steady effort, industry and loyalty to the company.

The report and accounts were unanimously adopted and the following dividends approved: A participating dividend on the Preference shares of 2½ per cent., making with the fixed dividend 9½ per cent. for the year; a dividend of 7 per cent. on the amount paid up on the Ordinary shares, equivalent to .84d. per 5s. share, 1s. paid, and a dividend of 1s. 11.056d. per 5s. Ordinary share, making a total of 1s. 11.896d. for the year, all less tax.

The proceedings terminated with a vote of thanks to the chairman, proposed by Mr. J. Lesser (general manager), seconded by Mr. F. G. Bell.

Experienced Moulders of Methacrylate Resins Choose HPM INJECTION MACHINES

One of the H.P.M. self-contained automatic injection moulding machines installed by specialists in the moulding of methyl methacrylate parts.
Careful and accurate control of all phases of the injection moulding cycle is essential when moulding transparent parts to optical specifications.

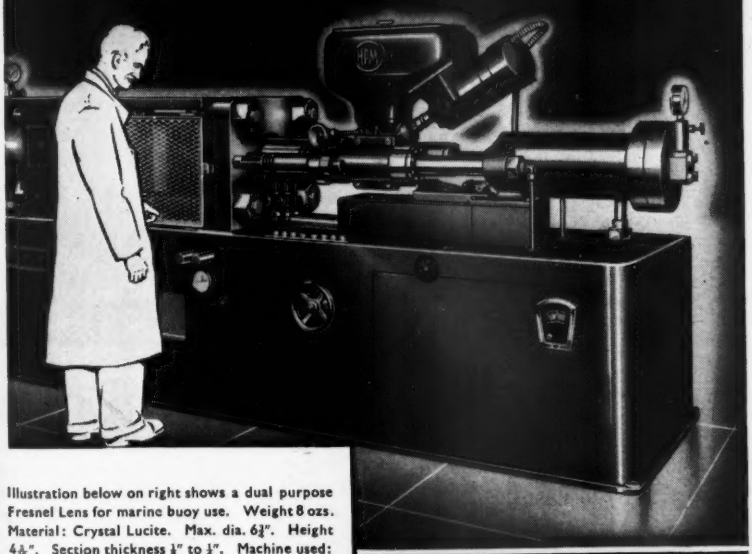
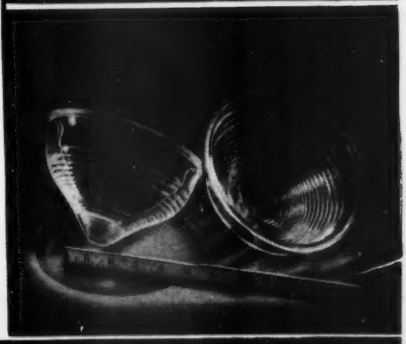


Illustration below on right shows a dual purpose Fresnel Lens for marine buoy use. Weight 8 ozs. Material: Crystal Lucite. Max. dia. 6¾". Height 4⅛". Section thickness ⅛" to ¼". Machine used: H.P.M. 200 H.9. (9 ozs.).



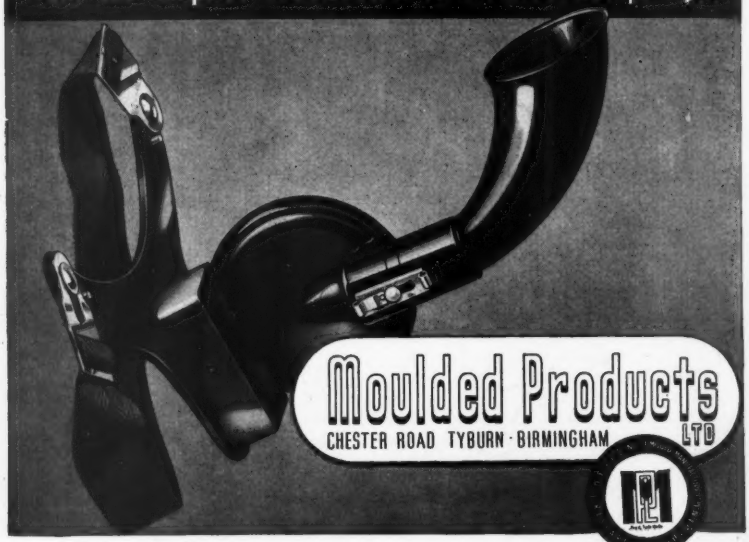
Manufactured by The Hydraulic Press Manufacturing Co., Mt. Gilead, Ohio, U.S.A., H.P.M. injection machines are designed to handle efficiently difficult moulding jobs such as the Fresnel Lens illustrated.

For complete specification write to-day to the Sole Agents and Engineering Representatives:—

A.C. Wickman LIMITED
COVENTRY • ENGLAND

LONDON BRISTOL BIRMINGHAM MANCHESTER LEEDS GLASGOW NEWCASTLE

From the simplest MOULDING to the most complex job



SUPREME IN SERVICE

Ensign Lamps conform in all respects to rigid B.S.I. specifications.

In other words, they are superlatively good lamps—as good as lamps can be; there's none better.

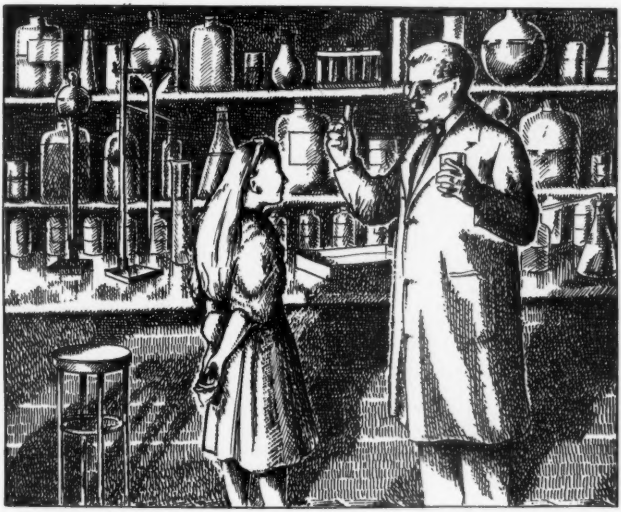
Yet they offer definite price advantages.

Well worth while enquiring from your supplier, or direct, before placing orders elsewhere.

ENSIGN Lamps

ENSIGN LAMPS LTD., PRESTON, LANCS.
And at London, Birmingham, Manchester, Glasgow, Cardiff, Leeds and Belfast.

Alice in Plasticland—No. 7



Alice learns about Research

"What is it you want to know?" said the chemist, gazing down on Alice benevolently. Alice wanted to know so much that she could hardly get it out. Alice had one of those enquiring minds.

"Don't worry," said the chemist understandingly. "We can explain almost everything about modern plastics here, for we've been experimenting in all directions for years. We'll always be more than glad to answer any queries you may send us. Just pop them in the post." And so saying he vanished in the direction of a tier of test-tubes.

ELO

PLASTICS

Full reliable information and data from Research Section, BIRKBYS Ltd., Liversedge, Yorkshire.

THE GAUGE AND TOOLMAKERS' ASSOCIATION LIMITED

Established as a central national organisation to further the interests of and promote co-operation between all Manufacturers engaged in the Gauge and Toolmaking Industry.

All information from the Secretary
STANDBROOK HOUSE · OLD BOND STREET · LONDON W.1
Telephone: Regent 3451-2

Ask this Man..

He is the man who has to use the tools you provide and he knows their merits. There is a Flextol machine for every job,—Filing, Grinding, Scurfing, Polishing, Flexible Disc Grinding, Screw Driving, Nut Setting, etc. Send for Catalogue No. F.31.

Flextol
POWER-DRIVEN HAND TOOLS
Regd Trade Mark

'More Power to your elbow'

Sole Manufacturers and Patentees:
FLEXTOL ENGINEERING CO. LTD
THE GREEN, EALING, LONDON, W.5
Phones: EALing 6444 (5 lines) "Grams: "Dismicating" Ealux, London

95-13A

INSTRUCTION IN PLASTICS TECHNOLOGY

A NEW organization has been formed to supply ambitious people interested in the Plastics Industry with modern instruction in Plastics Theory and Practice.

The new organization, known as The British Institute of Plastics Technology, is the specialist Plastics Division of The British Institute of Engineering Technology Ltd., one of the largest home-study technical training organizations in the world.

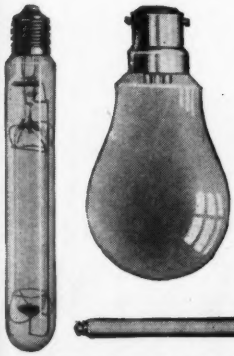
Specialist Plastics Courses are being prepared and will be available within a reasonable period. Those interested are advised to submit their names and addresses, when full particulars will be forwarded as our tutorial plans mature. Enrolment for the special courses will first be offered to those whose names have thus been recorded, but no obligation whatsoever will be incurred in lodging an application.

THE BRITISH INSTITUTE OF PLASTICS TECHNOLOGY
2, Shakespeare House,
17/19, Stratford Place, London, W.1

MORE LIGHT ON THINGS TO COME . . .

We've already gone a long way

While meeting the priorities of war Crompton Lamps have made great strides. With the complete lifting of the black-out you will find that Crompton have gone a long way in preparing for the brighter future.



CROMPTON LAMPS

for the LATEST in lighting

CROMPTON PARKINSON LIMITED. **ELECTRA HOUSE, VICTORIA EMBANKMENT, LONDON, W.C.2**

Telephone : TEMple Bar 5911 *Telegrams : Crompark, Estrand, London*

RM
SERVICE and DEPENDABILITY

Doing the job!

It is not always a question of metal substitution. Plastics correctly adapted may be the right material for the job. Save those machining operations. Have it moulded by :—

ROOTES
Mouldings Ltd

SLOUGH, BUCKS Telephone: Slough 22349

PRESSURE VESSELS
WITH PATENT QUICK OPENING DOORS

for the
PLASTICS
INDUSTRY

STEAM JACKETED PANS, AUTOCLAVES, HEATERS, CONDENSERS, ETC. OF WELDED CONSTRUCTION.

EDWIN DANKS & CO. (OLDBURY) LTD.
OLDBURY, Near BIRMINGHAM Phone: Broadwell 1381 2 3 London Office: 32 FARRINGDON STREET, E.C.4

REAL ACHIEVEMENT

More than a century ago when the "Royal William" set up a record for crossing the Atlantic in twenty-one days, the production of K.E. Steels was in its infancy.

During succeeding years, the introduction of many outstanding K.E. Special Steels has helped to bring about numerous achievements of both national and international fame. To-day the name of Kayser Ellison is more than ever synonymous with the thought of Special Steels for every purpose.

K·E·Special STEELS

K.E. 961 and other K.E. Special Steels for Mould Die Work—in Forgings or Bars, black rolled or precision ground finish.

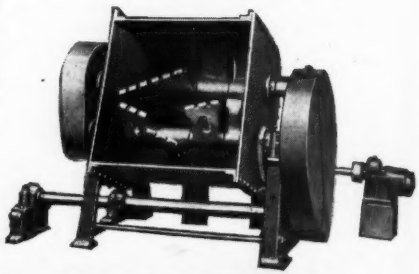
KAYSER ELLISON & CO. LTD.

CARLISLE STEEL WORKS, SHEFFIELD. EST. IN 1825

London Stockists (except for Stainless Steels):
FARMER, STEDALL & CO., 145-157 St. John Street, Clerkenwell, E.C. 1.
London Stockists for Stainless Steels:
MACREADY'S METAL CO. LTD., 131-135 Pentonville Road, London, N. 1.

"Principles" that evoke high "interests!"

The basic principles of design that mark the superiority of "Beken" Mixers over all others lie in their patent intermeshing blades. All mixing is done between the blades only, and NOT between the blades and the pans. This process gives a true homogeneous mix . . . quickly and economically . . . and the resultant fine quality of the finished product makes the "Beken" Mixer a highly profitable investment. The illustration shows a front view of the PTA Mixer, with the pan partly tipped for discharge.



BEKEN DUPLEX MIXERS

Sole Distributors: LAVINO (LONDON) LTD. Tel:—Chancery 6137/8
103, KINGSWAY, LONDON, W.C.2.

Sole Makers: E. HUNT & CO., LTD.
RIPPLE ROAD, BARKING, ESSEX.

BYSON FOR BAKELITE

Acetate and other Synthetic Mouldings. Modern Plant and Facilities

APPLIANCE CO. LTD
WOOLFOLD, BURY, LANCS.
Telephone: Bury 1560-1 Telegrams: "Bysonite, Bury."

ENGRAVED PLATES, DIES AND MOULDS FOR PLASTICS

J. MARTIN & SONS LTD.
DIE and MOULD MAKERS
18 Park Street, Higher Ardwick
MANCHESTER

"DING-DONG" HACK SAW BLADES—*Britain's Leading Blade*

Practically UNBREAKABLE

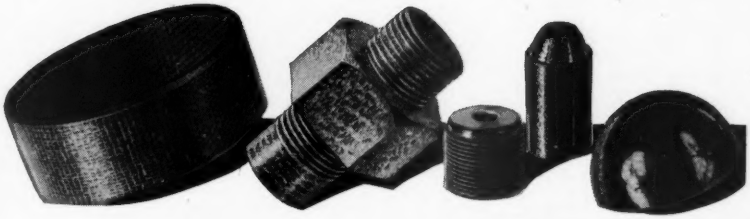
also HIGH-SPEED STEEL BLADES

SUPPLIED BY TOOL DEALERS, ENGINEERS' MERCHANTS, MILL FURNISHERS, ETC.

Manufactured by:

★ CHARLES BAYNES LTD., Knuzden Brook, BLACKBURN

Plastics Ahead!



THERE can be no doubt that plastics will play an ever bigger part in many branches of post-war Industry because they possess certain obvious advantages over materials hitherto used.

Ferobestos hard-wearing laminated Plastic is a most important contribution to the new field. It is the outcome of long and intensive research and experiment by specialists and the scope of its industrial application is extremely wide.

If you have new developments in view, you are cordially invited to consult our technical staff as to the many uses to which Ferobestos can be put. These specialists will gladly co-operate with you.

SOME OF THE ADVANTAGES OF FEROBESTOS

1. Does not swell in water or aqueous solution.
2. Withstands high temperatures.
3. Is economical and resistant to all but the strongest acids and alkalis.
4. Can be lubricated by oil, water or aqueous solution.

FEROBESTOS

PLASTIC PRODUCTS

MADE BY FERODO LIMITED • CHAPEL-EN-LE-FRITH

NOW LISTEN YOU FELLOWS—
what do you want from the plastic moulding people?

surely it is—

ADVICE upon which you can rely as to the type of Plastic best suited to the specification of your job.

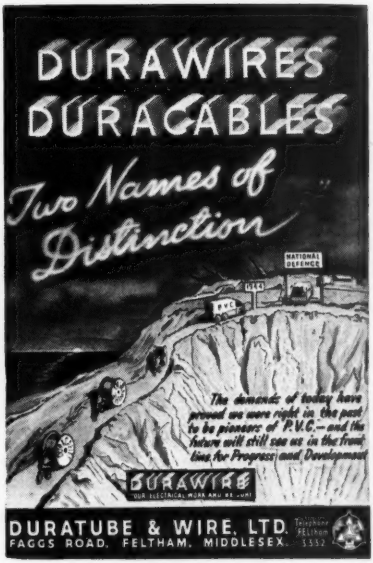
CO-OPERATION in the initial designing in order to make the job a sound moulding proposition.

CONFIDENCE that they will suggest the most economical and time-saving method of production and, above all, give you good mouldings and good deliveries.

THEREFORE GENTLEMEN YOU SHOULD CONSULT

CRYSTALATE

TONBRIDGE, KENT. HADLOW 233/4/5


DURAWIRES
DURACABLES
Two Names of Distinction
NATIONAL DEFENCE
The elements of today have proved we were right in the past to be pioneers of P.V.C.—and the future will still see us in the front line for Progress and Development
DURAWIRE
DURATUBE & WIRE, LTD.
FAGGS ROAD, FELTHAM, MIDDLESEX.

"Holly" Brand

TEXTILES FOR PLASTICS

are produced by

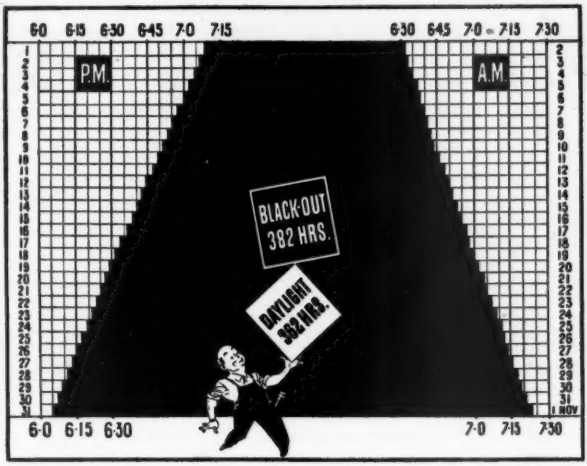
THE HOLLINS MILL CO. LTD. MARPLE CHESHIRE

All Enquiries and Correspondence to

5, PORTLAND ST., MANCHESTER, 1

"Stand Easy" black-out . . .

BLACK-OUT CHART FOR OCTOBER



★*Times shown are those for the London area.*

Reproduced from the Nautical Almanac by permission of the Controller of H.M. Stationery Office

Although black-out restrictions have been eased, it is still necessary partially to black-out every day and carry out full black-out during alerts. Therefore you need to know the black-out times. Nevertheless we hope by the time this announcement is published that the black-out will have been completely abolished then we can all Light up and Smile with Osram.

Osram

A G.E.C. PRODUCT

THE WONDERFUL LAMP

Advt. of The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2.

NEW!

VICTOR *Supermix*

X-RAY FILM PROCESSING CHEMICALS

★ LIQUID CONCENTRATES for GREATER ECONOMY and CONVENIENCE

EASIER, more convenient to mix—you simply pour these liquid concentrates into your tanks and add water. SPEEDIER film processing—development in 3 minutes at 68°F. and fixing in less than 1 minute. Alternatively you can reduce x-ray exposures by 20% to 25% to conserve tube life. ECONOMICAL—longer-lasting Supermix solutions will process up to 75% more films than with conventional powder chemicals. And, of course, Supermix development will ensure the utmost in film contrast, density and di agnostic detail.

PRICES

Developer:		Fixer:	
To make 1 gall.	6/6	To make 1 gall.	5/6
" " 2 "	11/–	" " 2 "	9/–
" " 5 "	27/–	" " 5 "	23/–

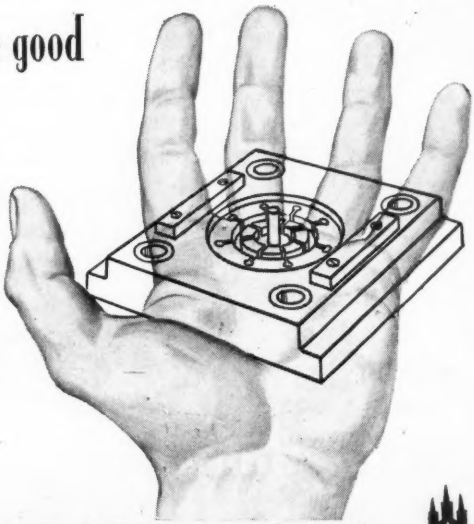
VICTOR X-RAY CORPORATION LTD.

15-19, Cavendish Place, London, W.1 LANgham 4074

Birmingham	55, Pershore Street	*Midland 2110*
Manchester	Milne Buildings, 66, Mosley Street	*Central 0275*
Glasgow	34, West George Street	*Douglas 1884*
Bristol	73, Queen Square	*Bristol 20890*

They have to be good

Dies and moulds for plastics have to be good; they represent a high level of precision engineering. At the back of them must be a tradition of craftsmanship, a wealth of costly machine tools and, above all, experience in this new industry. Cornercroft have them all; you can give us your plastics problems from the beginning and leave all the problems of dies and moulds to us; we have the organisation to find the answer.



CORNERCROFT (PLASTICS) LTD.

subsidiary of Cornercroft Ltd. ACE WORKS, COVENTRY

CPL.3

Tullis Russell & Co. Ltd.

MAKERS OF

BODY PAPERS

FOR THE

PLASTIC INDUSTRIES

AUCHMUTY & ROTHES PAPER MILLS

MARKINCH, SCOTLAND

LONDON	MANCHESTER	BIRMINGHAM
1 Tudor Street, E.C.4	372 Corn Exchange Buildings Corporation Street	116 Colmore Row

Reg'd Trade Mark

Moments *that* Matter . .

PERFECT teamwork, cool courage, and in a moment . . . another valuable life is snatched from "the drink." Mouldings have a job to do in the Air-Sea Rescue Service. It's such moments as the one we show here that make us put all we know into the design and manufacture of our products

For

Mouldings *that* Matter . .

Telephone: Footscray 1195.

KENT MOULDINGS

PROPRIETORS: KOLSTER BRANDES LIMITED

FOOTSCRAY, KENT

Telegrams: Kolsterphone, Sidcup.

Makers of Synthetic

RESIN PAPERS

(Impregnated and Coated)

For the **MANUFACTURE** of **LAMINATED SHEETS & TUBES**

CAMBERWELL BEAUTY
Regd. Trade Mark

SAMUEL JONES & CO., LTD

16-17 NEW BRIDGE STREET, E.C.4. PHONE: CENtral 6500

CLIPS- CLIPS- CLIPS-

Steel clips, bronze clips, stainless clips, big clips, little clips, wide clips, narrow clips, in fact clips in every conceivable shape and size.

Illustrated here—among others—are two of our stock patterns, 80 and 81, made in a range of sizes to grip from ¼" to 1½".

Maybe a clip of special shape would be necessary for the job you have in mind. Well, we can help you because we make clips for hundreds of uses, including war purposes. We can make to print or specification, or our Research Department will design for you. Our knowledge of clips has advanced side by side with our 88 years' spring-making experience, and we should like to send you our war-time catalogue.

Box 219.
6 doz. ass. sizes No. 80 and 81 clips.
12/6 *(Sub.)*

CLIPS by TERRY SPRINGS

* *and just a few special shapes we have made to order.*

Sole Makers: T.C.3
HERBERT TERRY & SONS LTD., REDDITCH
London — Birmingham — Manchester

C

OPPORTUNITY FOR EXPORT BUSINESS

Manufacturers and Manipulators in Plastic Goods are invited to get in touch with us. We have sales connections all over the world.

SPICERS (EXPORT) LIMITED

19 NEW BRIDGE STREET, LONDON, E.C.4. TELEPHONE CENTRAL 4211

What a Waist!

Waste in the modern factory is as out of date as the wasp-waist of the Victorian age. With the MASSON ROTARY CUTTER every bit of scrap can be reduced for reclamation. It is not only a question of War-time salvage but sound business economics.

Write for full information.

Not a Scrap Wasted

THE MASSON ROTARY CUTTER

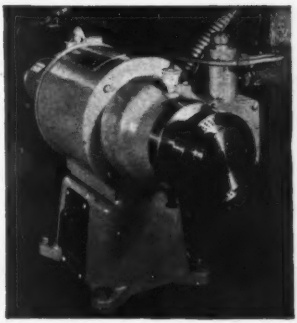
BLACKFRIARS ENGINEERING CO., LTD.,
BLACKFRIARS HOUSE, NEW BRIDGE STREET, E.C.4.

What - no set screws? HE SAID

That's right WE SAID

Chuck it! HE SAID

Vacuum Chuck it, you mean, we continued — that's the only possible solution to the problem of holding components for machining without distortion and with absolutely accurate location. Moreover, we went on, rubbing it in, with the Vacuum Chuck it is possible even in mass production to hold to 'tenths' where previously it was a problem to hold 'thous'. Perhaps we can design and make a Stationary or Rotary Vacuum Chuck that will solve some particular production difficulty in your factory? Gib precision for industry has the tools, the staff, the daring and, we believe, the happy knack of coping successfully with ticklish jobs.



1 Holds work-piece in metal or rubber without distortion.

2 Maintains the closest possible degree of accuracy in machining up to tolerances of ·0002".

3 Guarantees accurate location of component and makes it unnecessary to remove burrs caused by previous machining.

GIB PRECISION for INDUSTRY

The Vacuum Chuck

B. G. (London) Ltd., 17-19, Stratford Place, Oxford St., London, W.1.
Tel: May. 1585-7.
Works: Lewis Lane, Cirencester. *Tel:* Cirencester 434.

Men who do the impossible

Shannon Systems

THE SHANNON LIMITED

IMPERIAL HOUSE, (Dept. D.5), 15-19, KINGSWAY, LONDON, W.C.2

And at Birmingham, Bristol, Liverpool, Manchester, Newcastle, Glasgow (Agent)

VISIBLE CONTROL

The greatest aid to business control is the system that gives instant access to all vital facts and figures relating to the business. Shannon Visible Control in fact. Let us send you details. To comply with regulations please send Id. stamp.

The Plastics Boomerang

WE'VE ALL MET the customer who expects a cup to bounce *when it's made of Plastics* but who shows no surprise when one of china comes to grief under similar treatment. The remedy for this attitude of mind lies in a better knowledge of the uses and abuses of plastics. Advertisements by Bakelite Limited and others in the industry are doing much to educate the public. The moulder, for his part, can safeguard himself by using only the correct grade of powder for the job. The range of Bakelite moulding powders continues to grow. It may be that in the newer grades is a powder more fitted for the work in hand — one that will provide our critical customer with the physical characteristics he needs. Bakelite Technical Staff will give every possible help. The fewer boomerangs the better for the Industry.

TREFOIL

BAKELITE PLASTICS

REGD. TRADE MARKS

Pioneers in the Plastics World T17

BAKELITE LIMITED, 18 GROSVENOR GARDENS, LONDON, S.W.1

Vol. VIII. No. 89 OCTOBER, 1944

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - - M. D. CURWEN, B.Sc., A.R.I.C.
Offices - Bowling Green Lane, London, E.C.1

CONTENTS

	Page
Editorials	454
Plastic Protective Skins for Engineering Parts	457
Plastics in Tool, Jig and Fixture Construction, by E. E. Halls	460
World's Industry Employs Plastics	471
High Frequency Solves Moulding Problems, by L. L. Dawson	473
Protection of Radio Components for the Tropics, by W. J. Tucker	477
The Problem of Creeping Path in Plastics	481
Production News	484
Planned Mould Maintenance, by W. M. Halliday	487
Resinoids and Other Plastics as Film Formers, by B. J. Brajnikoff	498

NOTICES

All instructions, matter and passed proofs for all kinds of advertisements must reach the Head Office of "PLASTICS" by the 24th of each month to ensure insertion in the following month's issue.

TERMS—Monthly accounts, strictly net; due when rendered.

"PLASTICS" is published in London, England, at the beginning of each month.

Head Offices:
Bowling Green Lane, London, E.C.1.
Inland Telegrams - - "*Pressimus, Smith, London.*"
Cables - - - - - "*Pressimus, London.*"
Telephone - - *Terminus 3636 (Private Exchange).*

Midland Offices *(temporary)*: 241, Warwick Road, Kenilworth, Coventry.
Telephone / *Telegrams* } *Kenilworth* 415

Northern Offices—Manchester: Deansgate House, 274, Deansgate.
Telephone—Blackfriars 5038-9.
Telegrams—"*Presswork, Manchester.*"

SUBSCRIPTION — "PLASTICS" will be mailed regularly to any address in the United Kingdom or abroad for—Twelve issues for 19s., post free; pro rata for fewer numbers.

SAVE PAPER

More than ever is paper waste required for our war industries. Waste paper makes munitions in a hundred forms—from shell cases to aeroplane parts.

The fact that goods made of raw materials in short supply because of war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

EDITORIALS

Protection of Engineering Parts

ON another page in this issue we draw attention to a new extension in the use of plastic coverings for the protection of engineering parts. The method cuts clean away from the almost universal application of thin films, the object of which is to protect the metal unit from corrosion only, and utilizes instead a very thick film, some one-tenth of an inch thick, by a dipping process, using a molten compound produced mainly from ethyl cellulose. Thereby, it is claimed, is produced not only a strong film which is corrosion resisting, but also combines this desirable condition with the added advantage of establishing a covering which, in effect, will protect the contents from considerable damage during transport.

At first sight, the method is not a cheap one, if we consider that ethyl cellulose combinations (even with the low ethyl cellulose content of 20 per cent.) cannot be cheap; what is perhaps more important, a film of 1/10th-in. thickness is no cheap matter compared with the normal film of a probable 1/1,000th-in. thickness. Moreover, careful maintenance of the melt (at a minimum of 320 degrees F.) is necessary.

When, however, we consider that there is no time lag as with the evaporation of solvents from solutions, with consequent very rapid and indeed almost immediate production of the solid film, that an extraordinary large cost in packing is avoided, and that arrival at destination in perfect condition can, we presume, be guaranteed, some of the so-called high-cost problems may be found to vanish.

At any rate, the method has been approved by the American Government's Ordnance Department, which, indeed, has issued a special specification on the subject. It also throws a light on the extraordinary trends and advances in the protection of manufactured articles and on the importance of ensuring that they arrive at their destination, in all senses, in the best possible condition.

Adventures in Lower Limbs Coverings

A SHORT while ago we spent an extremely enjoyable hour lunching with the directors and managers of a large merchanting house which provides mankind, and womankind especially, with all its needs. These men were extremely interested and, indeed, knowledgeable, in plastics, and the talk revolved round their future application in the home, as fabrics and, of course, as raw materials for the manufacture of those glamorous, diaphanous coatings they call sheer stockings. We discussed acetate, viscose and nylon and other things to come, and then we said how we had often watched with fascination the sudden dart from knee to instep—the snake-like strike—of the stocking "run." Tears came to our eyes at the thought of the awful wastage of good acetate, viscose, nylon and silk, the women hours wasted in darning, and the dreadful cost of buying replacements.

Our tears did not seem to affect the hearts of these hard business men, for we did not notice any of them burst out crying. Indeed, one might have concluded that the stocking "run" is now an integral function not only of stocking usage but an integral factor in the profits made in the business.

There is probably much truth in this, for, of course, production is equal to demand and it may be necessary to shoot at sight the light-hearted inventor who discovers how to eradicate laddering with

certainty. Nevertheless, it would be foolish not to realize the urgency of such an invention.

The cause of "running" lies in several characteristics of the woven fabric—in the strength of the thread (doubtless a nylon incurs less damage than a weaker thread) and presumably "runs" less, in the manner of weaving, in the roughness of the thread (wool garments woven in exactly the same way as stockings do not "run"), and so on. Improvement in any of these factors, therefore, will improve the stocking.

It is interesting, therefore, to note a recent announcement by Monsanto Chemical Co. of a method entitled Syton treatment, which comprises the immersion of fabric in a fine colloidal dispersion of silica or quartz, resulting in a hard, translucent coating of particles of the latter, each under 1/400,000th of an inch, on the individual fibres. This film is stated to decrease the tendency of fibres to slip and so diminish laddering.

It is possible that the true solution lies in the complete elimination of the knot, which is not a knot. We can give our imagination play and devise a method of welding those danger points by heat and compression or, one day, by high frequency. Thus "runs" would never occur in any plastic stocking whether the fibres were strong or not.

Education in Plastics

WITH the extraordinary growth, healthy and unhealthy, of interest taken by the general and financial public in plastics and the plastics industry, we are all very conversant. Co-incidently, and in direct proportion to this growth, there has increased a demand by youth and parents for educational advice on the subject and the best means of getting into the industry. What, therefore, is most encouraging is the gradual improvement in facilities for receiving a good groundwork in both the elements and in more advanced aspects of chemical and engineering sciences as applied to plastics.

Most of us will always remember and be grateful to the pioneers in plastic education. The work done by Dr. Redfarn at the Borough Polytechnic and by others elsewhere, cannot be readily assessed, but its value is extremely high.

To-day, in London alone, there are four technical centres which give excellent instruction: The Borough Polytechnic, the Northern Polytechnic, the South-West Essex Technical College and Enfield Technical College. In Birmingham the Central Technical College in Suffolk Street provides part-time day and week-end courses. No doubt to these will be added courses which will enable students to work during evenings. At the University College, Southampton, at the Municipal Colleges of Bournemouth and Portsmouth, and at the Technical Colleges of Stroud and Wednesbury, new courses have begun during the past year or so.

What, however, is perhaps more striking is the attitude taken up by the College of Technology, famous for its teaching of organic chemistry—dyestuffs and textiles in particular. Here, in addition to an excellent series of evening courses, a special part-time course, which may cover six years includes, for the first time in this country, the study of the chemistry of macromolecules. This is tremendously important.

New Books

"Plastic Molds," by Gordon B. Thayer, M.E. Second Edition. Published by American Industrial Publishers, Cleveland, Ohio, 1944. Pp. 136. Price $3.50.

When this book was first published in 1941 under the title of "Plastics Mold Designing," its authoritativeness was immediately recognized. Unfortunately, exigencies of war-time and difficulties of exchange resulted in but few copies reaching this country. The situation is now much eased and no doubt there will be an increased demand for what is one of the very few published books on the subject.

The new edition is much enlarged, the 20 chapters now containing many more designs and types of moulds, with over 80 drawings and photographs.

A valuable feature consists of contributions by several specialists, one of whom, Mr. F. G. Woodiwiss, has done much to promote good design in England.

The subject-matter is, generally speaking, confined to mould design, and includes designs of simple compression mould, split cavity compression mould, side-opening compression mould, transfer-type mould, simple injection mould, stripper plate injection mould, loose-bar injection mould, and injection mould for a plastic lens. Injector systems, methods of moulding screw threads, and methods of mould sinkings are also discussed, while a good chapter on finishing methods and the inclusion of shrinkage charts concludes the book.

" Plastics for Production," by Paul I. Smith. Published by Chapman and Hall, Ltd., London. Price 12s. 6d. net. Pp. 180.

The author, who, before joining the Army, was assistant editor of " Plastics," has produced a review of plastics and their properties which should prove of considerable value to those industrialists, especially engineers, who need a book of reference.

The technical data and general information have been carefully collected and is up to date, while the arrangement of the material is quite interesting. Nevertheless, it seems a pity that the author has separated certain chapters which might, with advantage, have been brought together. Thus, the early chapter, " The Range of Plastics," is separated by six following chapters on their application from " Main Thermo-setting Resins " and " Main Thermo-plastic Resins."

The six chapters mentioned form the kernel of the book, for they include " Plastics for Insulation," " Plastics for Moisture and Chemical Resistance," " Effects of Temperature," etc., and will prove of considerable use to engineers in their understanding of the new constructional materials.

As a footnote, we remark on the inclusion of methyl cellulose in the list of thermoplastic resins. We do not know of any such use and the statement that it is soluble in cold water and insoluble in hot is strange, in view of the fact that dispersions are made by pouring boiling water on to the substance. This is a minor point which, no doubt, will be corrected in a second edition.

" Wood-flour," by W. S. Dahl. Pp. 44.

This interesting little booklet, which has been privately printed by Mr. W. S. Dahl, of 30, Stanley Road, Mortlake, London, S.W.14, contains a good deal of information regarding the manifold uses of wood-flour considered as a specially produced compound by rigidly controlled engineering means. The story of the progress in production of wood-flour as an entity separate from the " grosser " sawdust is interesting, for by that means, no doubt, new industries were created. Certainly there are still other industries to be explored and still newer ones to be born.

While the use of wood-flour as a filler in linoleum, plastics, concrete, toys, rubber, and so on, is adequately told, we may be permitted to hope that one day the author will expand his book to include what can be done with sawdust, too, and thereby help our woodworking and our chemical industries. There is much to do still in turning an important waste into valuable chemicals. The problem is difficult, but the solution is worth while.

Symposium on the Applications of Synthetic Rubbers

The purpose of this symposium developed for the American Society for Testing Materials Committee D-11 on Rubber Products by a special section headed by Arthur W. Carpenter, was to meet the present need for authentic technical information on the uses of various synthetic rubbers. The publication is considered timely because of the rapid increase in the use of synthetic rubbers in many fields, and the lack of a compilation of data on their efficiency and serviceability in these fields. Some of America's outstanding authorities presented technical papers and discussions. There are also papers on the origin and development of synthetic rubbers (Fisher) and on physical testing (Cooper); there is a comprehensive discussion on physical properties (Ball and Maassen); specifications (De France); and an interesting evaluation of processing characteristics and the use of synthetic rubbers in the manufacture of extruded products (A. E. Juve).

Then follows a series of papers covering specific applications, including rubber tyres and inner tubes (Torrance); belting and hose (White); moulded products (Sanger); cellular rubbers (Gould); hard rubber products (W. H. Juve); use in the wire and cable industry (Schatzel); footwear (Glover); and adhesives (Wehmer).

Copies of this 140-page publication, which includes a large number of charts, tables, etc., can be obtained from A.S.T.M. Headquarters, 260, South Broad Street, Philadelphia 2, Pa., at $1.75 (cloth binding) or $1.50 (paper binding).

Plastic Protective Skins for Engineering Parts

The war of machinery, in tropics and arctic regions, has focused attention on the means of getting valuable precision machinery and replacements in perfect condition into the front line. In the battle of science against the elements there have been evolved new systems of protection which, although in their infancy, promise much for the post-war years. Among these systems, the tough protective skins made from plastics and herein described are among the most valuable.

ONE of the greatest and most important of developments that has been evolved during, and as a result of, the war, a development that will most certainly have a profound effect on the engineering and allied industries in peace-time, is that of protection of machinery parts and engineering units—gear wheels, ball-bearings, connecting rods, bushes, pistons, instruments, and the thousand and one other objects that form part of naval, military and air force equipment which must be stored under a variety of conditions on land and sea, at home and abroad, and in temperate, tropical and arctic zones. The unit may have to be protected against simple or complicated corrosion problems occurring in tropical forests, sea-water, or storage, against bacterial attack (it is surprising to learn how readily bacteria can grow on lubricated machinery parts and spoil finely polished surfaces), as well as physical damage due to the exigencies of modern transport during loading and unloading of ships, rail-wagons and lorries. In the bad pre-war days manufacturers seemed loath to take the costly incidence of even breakage seriously enough, as this could be taken care of by insurance.

One great truth has certainly emerged, at least in war-time. It is worth while taking the greatest care, in spite of extra cost, in getting the unit where it is wanted, in the condition it is wanted. It is not much good transporting a piece of high-precision engineering 5,000 or 10,000 miles to find that it is too rusty to use.

Early Methods of Protection

Almost the only method of protection in pre-war days appeared to be a liberal covering of grease, petroleum jelly or straight lubricant or the more common covering with lanoline, the latter being employed in the form of a solution in naphtha, into which the part was dipped. Each of these methods gave fair protection under simple conditions, such as storage in temperate climates, but even these sometimes failed because of lack of water resistance, development of acidity or other reason. Obviously, too, they possessed a characteristic which was often a disadvantage—too easy removal by rubbing or similar action. A more recent development in lanoline protection has been the inclusion of a proportion of resin into the formula, and yet another material that has been examined by the R.A.E. is that of special resinous solutions, free from lanoline, which leave a hard, tough, water-resistant film on the unit on evaporation of the solvent. While this last-named type is of considerable use for storage purposes in this country and, indeed, for transporting certain objects, yet it has its drawbacks when, as in the case of very accurately machined goods, the film must be removed in districts when even simple removal in white spirit is difficult. Artillery units cannot be expected to perform this operation in the field.

Recent Developments in America and Great Britain

In both countries recourse has been made to the use of loose and close plastic skins for the protection of valuable material. Regenerated cellulose and

cellulose acetate sheet have been commonly employed and, more latterly, the thicker sheets of rubber hydrochloride and of polyvinyl chloride have been used to wrap and protect objects ranging from rifles to special incendiary bombs. In this country, especially, good progress has been made in the art of hermetically sealing the casing of polyvinyl chloride by means of high-frequency current. This type of covering is, of course, of the loose kind. It is claimed that objects so covered with p.v.c. can be thrown into the sea and retrieved intact.

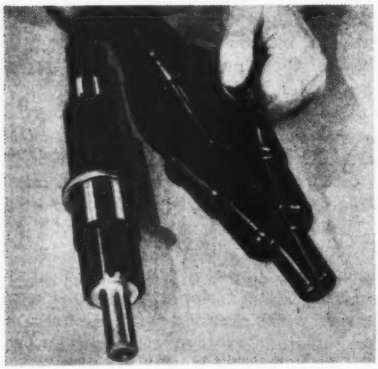
In the United States there has grown the realization of the importance of producing a closely fitting skin of considerable thickness, and not a thin film, which would at once be a protection against corrosion and against damage during rough handling. It has also been realized that the skin so formed must be readily removable and must leave the metal surface easily and cleanly.

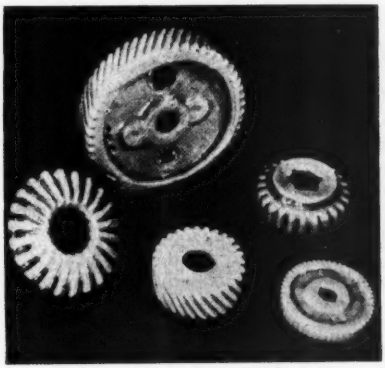
Obviously, a nitro-cellulose lacquer would fulfil some of these characteristics. A strong skin is readily formed by dipping and is equally readily and cleanly removed. Such a skin has not been adopted perhaps because of possible corrosion on storage or the time lag to obtain thick films (1·10th in. is a standard requirement for the job).

In a recent issue of "Modern Packaging" there is a description of the use of specially compounded and modified ethyl cellulose for the purpose, which cuts out time and manpower-consuming methods of coating with rust-inhibitors, wrapping in greaseproof paper and other methods of sealing so general in use. It is claimed that from 62 to 90 per cent. has been the saving in time alone.

The coating material consists of a base of not more than 25 per cent. ethyl cellulose modified with oils and resins and which is sold in the form of slabs, which are broken up for melting. The melting point is comparatively high, the material being maintained in an electrically heated dipping pot at a maximum of 390 degrees F. A specially designed pot with internal heating and stirring devices to prevent decomposition and to maintain fluidity has been suggested.

The metal object is dipped into the hot melt and, on removal, almost immediately solidifies, covering the unit with a very tough skin about 1·10th in. thick. In order to facilitate removal of the plastic skin on receipt a wax-impregnated string is used during the dipping as a suspension and is included in the package. When pulled, it acts on the





(Photos: Courtesy of "Modern Packaging."

Figs. 1 and 2.—The above engineering units have been covered with skins made from ethyl cellulose. Fig. 1 shows the skin removed.

Fig. 3.—A chromium-plated closed tube with a thick skin of the Resin AW/20 described below. The coating has been slit with a knife and pulled away, leaving the polished metal surface quite cleanly.

rip-cord principle, cutting through the plastic coating. Since ethyl cellulose is strictly controlled it is unlikely to reach non-essential industry until after the war.

A British material which is now under examination is similarly employed as a hot melt. Known as Resin AW/20, it is not a hard material like the ethyl cellulose composition, but has a rubbery texture. It is, nevertheless, simpler to remove from the unit as it cuts easily with a knife and peels off cleanly. It is highly resistant to water, bacteria, fungi and insects. The coating is carried out as with the ethyl cellulose, the melting pot being maintained at about 330 degrees F. By suitable modification, the viscosity of the hot fluid can be altered to give any desired thickness of skin.

It is certain that the protective plastic skin has a big future in post-war years, when uses other than for covering engineering units may be discovered, especially if melting points are lowered. Thus glass could be protected.

Acid Containers

Dangerous corrosive acids can now be transported with considerable safety by the use of plastic-fabricated containers, according to "Scientific American." Collapsible emergency holders in flexible disc form have been developed by the United States Rubber Co., and, it is stated, will carry hydrofluoric acid, etc., without deleterious results. They are assembled in two parts in sheet form, one being of cotton fabric treated with "Vinylite," and the other with synthetic rubber. The G.R.S. type has been used.

They are held together with small eyelets spaced about 3 ins. apart, which are stapled into the material. A lightweight cord is drawn through the eyelets. The completed article is then ready to be placed around either a glass or metal container and drawn tight, much as a tobacco pouch, to insure against spillage.

Plastics in Tool, Jig and Fixture Construction

By E. E. HALLS

ALTHOUGH the term " tool " is very narrowly interpreted by many people, it can have a very broad significance. Certainly a very wide conception has to be accepted in considering the possibilities of plastics in this sphere of activity. Actually, plastic materials always have figured among the necessities of the tool-making department. They have served indisputable purposes for which it is probably correct to say that there are no substitutes, or at least no efficient substitute materials. Their use has been accepted without question and perhaps without appreciation of their nature. The position to-day is somewhat different. The range of plastics established commercially is a very wide one, with possibilities of providing many modified forms to suit specific requirements more closely. The manipulation of these plastic materials, whether through machine-shop operations of blanking and piercing, drilling and tapping, milling, polishing, and shaping in general, is well established, and executives as well as operatives well versed and experienced in these matters are dispersed throughout all industries of an engineering nature. The properties of these materials can in the main be well defined and often expressed in a numerical fashion with close exactitude. The plastics industry to-day is probably well up to the general level in the metal industries in these respects. Again, experience with plastics under service conditions of a diversity of types has led to an accumulation of knowledge from which their shortcomings or meritorious features can be foretold. The result to-day is that plastics serve a merited demand in work associated with tools, jigs and fixtures. The tool designer must have before him some form of classified list of plastic products with data upon their mechanical and physical properties, their amenability to shaping, the possibilities of hot pressing and moulding, and so forth. This is becoming an essential item alongside the ready reference to the carbon steels, alloy tool steels, standard shapes and sizes, etc. In the toolroom proper, toolmakers have to become plastics conscious to appreciate the similarities and dissimilarities of metals and plastics. They must avoid deciding too quickly that a method of shaping the new materials is impracticable without making such adjustments to technique as may be demanded by difference in characteristics.

However, it cannot be stressed enough that the conception of the plastic tool must not be too freely envisaged. Broadly speaking, the plastics do not substitute existing materials so much as they provide a complement to them. They are selected on their own merits to meet specific conditions obtaining. It is advancement in engineering that has enabled plastics to enter this field, even if in some cases it is the use of plastics that has permitted the advancement to be achieved. Readers must therefore not conjure visions of heavy press tools, yesterday requiring months of hard work to produce from steel, with numerous heat-treatment operations and troubles in consequence with shrinkages and cracking, to-morrow machined or cast, or, by a combination of the two, in plastics with no tricky thermal processing, completed in a few hours. It must be borne in mind always that even plastics can only serve in so far as their limitations permit, and the new techniques that they introduce can be applied. The most fruitful channels of application are those that

were impossible previously, those which gave rise to continuous difficulty or running troubles, and, above all, new designs and methods. In general, the " plastic " jig, tool or fixture should not be envisaged to the exclusion of all else, but plastic raw materials should gradually and rapidly fall into position in the tool designer's outlook. Clarity of vision of their properties in all senses should be acquired in just the same way that it normally exists with steels and woods, glass and brass, rubber and felt, etc.

Definitions

Many workers in engineering conceive of a tool merely as an instrument by means of which operations of pressing, spinning and hammering, cutting, drilling and tapping, and the like are performed. Again, broadly considered, many people confine their association of tools to engineering industries. Fundamentally, these viewpoints may be correct, but such outlooks are too cramped, at least for the purpose of this article. In some industries, a tool is defined as the actual medium employed for shaping the raw material in the fabrication of the final article. Qualified expressions are employed, such as press tools for punches and dies used on hand- or power-driven presses for blanking, cupping, drawing, forming, powder pressing, etc.; cutters or cutting tools to describe those used on milling and automatic machines; small tools to embrace all items of the classes drills, taps and reamers. Jigs and fixtures, under this system of nomenclature, are not included as tools but are regarded as supports or holding devices. Thus, a jig is defined as the means of holding or supporting the tool, while a fixture is the means of supporting the work. There are occasions upon which this clear distinction is useful or beneficial, but generally the discrimination can become misleading, and outside the tool departments proper it is usually found to have little significance or recognition. Often the tool proper and the jig are detailed on the same drawing. The same departments cater for the design of jigs, tools and fixtures, and the same remark applies to their production. Practically always these are referred to as " tool design " or " tool drafting " and the " toolroom " respectively, while the associated inspection department is described as the " tool inspection." Various grades of skilled labour classed as " toolmakers " are entailed in their production, and each " tool " or each part of a " tool " needs to be given specific consideration with respect to accuracy of dimensions, material from which made, the function of each part, service conditions in relation to material, with special reference to mechanical properties of strength, hardness and shock resistance. Further, with the extended use of automatic machinery, close definition of the functioning components on a basis of their rôle becomes increasingly more difficult, particularly if tools are to be made readily adaptable for quick removal of one inset and replacement by another. In fact, with combinations of automatic machines and conveyorized handling, it may ultimately be found very difficult to draw a rigid line of demarcation between tool and plant or tool and machine.

In the following, no attempt will be made to conform to engineering definitions when referring to tools, jigs and fixtures, and overlapping may occur. Some aspects of interest will be presented concerning the use of plastics in these items. Reference will not necessarily be confined to what is strictly regarded as the engineering industry, but will be extended to embrace the chemical, chemical engineering, food and pharmaceutical trades.

Probably the full range of plastic materials finds application in the " tool " sphere, but it is difficult to classify the materials with respect to serviceability. The recognized sheet, rod, tube and section shapes, mouldable powders, and the polymerizable liquids are used, as well as cements, adhesives and lacquers. Most of the plastic types, the phenolic and amino thermosetting plastics; the thermoplastic materials, cellulose acetate, polythene, polyvinyl chloride, the metha-

crylates; the casein products; zinc chloride vulcanized fibres; the natural rubbers, hard rubbers and synthetic rubbers: all these among others serve useful rôles. Cast resins, moulding powders having various fillers for modifying mechanical properties, the laminated sheet materials having paper, fabric or asbestos, in different grades, can be chosen to best suit individual purposes.

Factors in the Problem

Brief consideration of the properties which cause attention to be focused upon plastics is of interest. First, however, let it be stated that tool manufacture is expensive and in engineering industries it constitutes one of the heaviest loads upon overheads. Generally, expense accompanies accuracy, and the one cannot be eased without forgoing the other to some degree. The main toolroom material is steel, and much of this comprises alloy steels of relatively complex composition. It is expensive material, rendered even more costly by the high degree of purity to which it must conform, freedom from inclusions of slag and foreign matter, etc. These steels are heavy, densities being in the neighbourhood of 8.5, and this adds to cost because of their handling through receiving and inspection departments, in stores, especially during the issue of small quantities, through all tool-making operations and intermediate and final inspection stages, as well as during the passage of the tool to the shop, setting-up, various dismantlings for reconditioning, etc. Various grades of tool steel are used for different purposes, and each has its own heat-treatment conditions. Scrupulous care must be taken to keep stocks identified and to avoid mixing, since they all look closely the same. Heat treatments invariably carry with them troubles from faulty heat treatment, soft spots, cracking, etc. Furnace and quenching equipment must be available for precision heat treatment. Close temperature control and precise uniformity of furnace chambers are essential. A range of furnace capacities may be necessary to take care of tools varying from very small to large sizes. The final tools themselves have to be carefully handled with avoidance of mechanical shock and with protection by approved greases or oils to prevent rusting. Not all tools, of course, necessitate heat treatment.

The notes in the last paragraph are given not because plastics overcome such complexities and cause a large expense saving, because this is rarely, if ever, the case. On the other hand, they are presented to emphasize the contrast: first, something that plastics cannot undergo; secondly, something that plastics do not involve. It is particularly in these directions that, with modern advancements, design for plastics has enabled their advantages in some of these directions to be exploited.

The plastics are low-specific-gravity materials, generally the lowest being about 0.9, the average in the region of 1.2 to 1.4, and the heaviest somewhat less than 2.0. Major advantages therefore accrue in this direction alone at all stages of tool production and use, from the receipt of the raw material to the setting-up of the tool in the machine.

Perhaps the next features of plastics are the combined qualities of inertness, freedom from tendencies to corrode and cleanliness of handling. From the foregoing, the import of these properties is readily apparent and no further comment is required.

Next should be mentioned amenability to fabrication by toolroom procedures. By and large, no difficulties arise, and processes that are applicable are as simple to perform as they are with the metals and generally with wood; they are easier than with glass or ceramic. It does not always follow that the same close dimension limits can be obtained or maintained, and discretion in choice of material arises. Powders can be obtained in many grades for simple hot moulding to shape, or to approximate shape, probably more readily than metals can be cast under the same sphere of conditions. This applies to thermosetting and to thermoplastic types. Shapes can also be secured from

thermoplastic sheet, rod and tube materials, thus simplifying toolroom operations, rendering them quicker and less expensive.

A range of mechanical properties can be secured in plastics to meet conditions of tensile strength, crushing loads, impact shock, shear or torsion. Physical properties of transparency are easily met, so that the danger from shattering glass can be avoided, or complete guarding still providing vision can be secured, or even special optical properties provided.

The chief attributes of the plastics are therefore lightness and inertness, amenability to fabrication, special facilities for shaping by hot moulding or pressing to shape, and in some forms transparency. In this summary, multiplicity of types should also be included because of the variety of service conditions fulfilled on this score alone.

Limitations of Plastics

On the debit side some limitations should not be overlooked. Plastics, in terms of price per pound, are expensive, just as are the tool steels, but it has already been inferred that material expense is by no means the major portion of tool cost. Labour is the principal item, and rapid production of sound tools with minimum of maintenance is the keynote to minimized expenditure. Density does not necessarily diminish the cost figure, because in many instances added thickness is necessary to compensate for rigidity or strength. Again, with the thermosetting plastics, there is no recoverable scrap as there is with metals; with the thermoplastic varieties scrap has a market value, but in a toolroom where individual details are being produced contamination with metal scrap is inevitable and segregation rarely worth while. Scrap plastic is thus a loss, a feature to bear in mind at the design stage so as to keep it to the lowest level.

The response of metals to temperature fluctuations is a well-defined expansion or contraction following a linear law. With plastics, expansion is rather higher, and return to the original dimensions does not follow; first, because a slight degree of drying out or loss of plasticizer may occur; secondly, because some degree of plastic flow may result if the part is held under pressure during the temperature cycle. The possibility of any peculiar phenomenon arising due to this must not be overlooked.

Except for corrosion, such as rusting—and it has already been indicated that this point must be cared for—metals are immune from humidity changes. With plastics, however, some dimensional changes may occur, dependent upon the nature of the plastic base, the filler material incorporated in it, and the nature of plasticizers, if any, that may be present. The normal grades of bakelite-moulded material are almost inert in this sense; mineral-filled qualities are quite inert. With the laminated grades of high quality very little change occurs with paper laminated and little greater with fabric laminated. Greater expansions occur in the lower grades, however, and in some of the low-resin-content fabric products marked swelling can occur under very damp conditions. The effect of oil is considerably less pronounced, but must not be overlooked with the poorer qualities of material; poorer, that is, in resin content, although they may be much superior with respect to shock absorption, for example. These are factors to be included in any study of items likely to be used as jigs or fixtures where continuous lubrication is resorted to, and water solutions of soda, or of soluble cutting emulsions, or even straight cutting oils themselves, are used.

The thermoplastic materials respond to heat and humidity changes not only due to loss of plasticizer and moisture absorption, but possibly also upon account of structural changes within the micelle of the plastic particle. Service conditions and freedom of mounting often determine choice. Thus guards of cellulose acetate sheet must not be rigidly fixed in frames, but held freely, otherwise shrinkage and expansion cause ultimate fracture. On the other hand, methyl methacrylate is dimensionally very stable unless subjected

to temperatures above 60 degrees C. It is therefore a suitable material for rigid fixing in guard frames.

In this summary of merits and shortcomings of the plastics for tool work, comments have purposely been kept to those of a general nature, the advantages claimed confined to the more obvious, and the disadvantages to the less frequently remembered points.

It is interesting to note that the one industry in which jigs and fixtures extensively utilizing plastic base materials have been systematically exploited is that of aircraft assembly. In this field jigs and fixtures are large, and raw material of big area, easily handled and readily shaped, is essential. Plastics should be capable of fulfilling the need in this direction for inexpensive, light fixtures very well indeed, and it is significant that exploitation in America, where the plastics industry is on a large scale, is firmly established.

Existing Practice

Attention is called to a recent textbook entitled "Jig and Fixture Practice" (1944), by H. C. Town, published by Paul Elek (Publishers), Ltd. The subject is very clearly written and informatively presented, and the book includes a chapter headed "Plastic Jigs and Fixtures," under which brief reference is made to some types of plastic materials used and the service to which placed, with illustrations. As this information is of general interest, some notes are summarized from Town's book in the following:—

Cast plastics have particularly been utilized in the aircraft industry for jigs and fixtures. Time saving has been the primary objective of this, and a reduction from two weeks to four hours, the latter including a two-hour baking period, is a typical example of the benefit gained by plastics from this feature alone. In the American Lockheed and Vega plants, fixtures using nearly 40 gals. of plastic material and weighing as much as 380 lb. have been made. The fixtures replaced by these plastic tools weighed seven times the identical shapes in plastics. Lightness in weight assures easy handling. If damaged, local repair is simple at low cost. When obsolete, they are reground and the plastic reused, a process which it is claimed can be repeated several times.

The Art Plastic Co. and the Brewster Aeronautical Corporation have developed a thermosetting plastic mass called Formrite. It is a combination of organic and inorganic material having a special accelerator which enables it to cold flow and solidify without any special baking. The chemicals in it generate heat by reaction to raise the mass to within the range 200 to 300 degrees F. The mass thereby sets, but being thermosetting, it cannot be reground and used over again. Three varieties are made—for drill jigs, for stretch dies and inspection frames, and for mandrils, respectively. The Formrite powder and accelerator are mixed in bulk as required and poured almost at once into the moulds. Setting time is about 24 hours.

Jigs in Formrite are made by casting around a sample of the actual component, thus saving almost indefinite toolroom effort in making a fabricated jig. Drilling of aluminium castings can be done against the clamps, but normally jigs are made so that machining is against a positive face. The Formrite does not spring or warp under reasonable drilling pressures, nor does it soften under the temperatures generated by drilling. The grade of Formrite used has a compressive strength of about 8,000 lb./sq. in. and a tensile strength of about 480 lb./sq. in., and possesses machineability comparable with that of cast iron.

In the case of intricate sections, it is possible to make plaster casts from these sections and then to reproduce the jigs in Formrite from these casts.

While reinforcement is not usually necessary, steel can be used for inserts for sharp edges. Work has been done on the use of electro-plating, but no commercial result is reported as achieved to date. Regarding the nature of the

material for the mould, there is no fastidious requirement, and wood is usual. A simple wooden frame serves for casting jigs for drilling. The master workpiece forms its own shape for the bottom of the mould and likewise for the top drill plate carrying the bushes. The location of these bushes is, of course, important, and several methods are followed. In one of these the drill bushes are bolted in position through their bores and clamped with exactitude to the work. When the plastic has set around them, the bolts are removed. An alternative procedure is to cast the plastic in the normal way, solid, without bushes, and then to drill the holes in the plastic for the bushes from the work-piece itself. The bushes are then set in cerromatrix. The latter is a low-melting-point alloy of tin, lead and antimony, melting point about 102 degrees C., which sets a limit upon the setting temperature of the plastic and its control. The cerromatrix expands during solidification to the extent of about 0.002 in. per in., and, in consequence, the bushes located with it are locked fast and remain rigid. Nevertheless, it is wise to anchor the drill bushes by means of grooves in such a manner that neither axial movement nor rotation can occur. This is necessary because it is evident that no alloying or soldering effect, nor chemical reaction to promote keying, can be expected between the plastic and the fusible alloy. The alloy is soft, Brinell hardness being only 19, but it is strong, as shown by the following figures:—

Tensile strength, 13,000 lb./sq. in.

Compression strength, 16,000 lb./sq. in. for 30 seconds, or 8,000 lb./sq. in. for 5 minutes.

The woodwork or sheet of the mould can be retained on the plastic jig for mechanical protection if desired, especially if the jig is of fragile configuration or subjected to rough usage. However, Town points out that the service life of a plastic jig, if handled properly, compares favourably with that of a metal one. If replacement is needed at short notice, due to accident, production is very rapid. He quotes an example of a steel jig requiring 90 hours of toolroom effort, and the corresponding plastic jig which required only two days in which to complete all phases of the work, including the making of the mould, pouring the plastic and setting it by baking. Incidentally, in operation it was found that the plastic jig could be much more rapidly loaded than the metal article.

Town mentions the use of densified laminated plywood, which is virtually phenolic resin laminated wood, i.e., similar to the well-known paper and fabric laminated materials, but having thin wood sheet as filler material. It is available in several grades, distinguished by the proportion of resin to wood and therefore yielding a range of mechanical properties with respect to strength, compressibility, resilience and hardness. Such materials require machining, of course, although this can be considerably reduced by using suitable moulded sections or shapes in the same material rather than relying solely upon sheet or blocks. Cementing is also useful to curtail or augment screwing and bolting. This class of material will be referred to later in more detail.

Aircraft Assembly Jigs

Reference is given to "The Iron Age," October 1, 1942, in which W. D. Lewis, of the Timm Aircraft Corporation, discusses the use of plastics for assembly jigs. In large work, the use of wooden cores is advocated in order to minimize the quantity of resin consumed, this, of course, being a feature of economics. This entails close attention to the degree of dryness of the wood, and, in the jig itself, fluctuation in the water content of the wood with changes in the humidity of the surroundings, and the consequent dimensional changes. Trim jigs are made in exact reverse of the components to be trimmed by using the die with which the components are stamped, constructing a simple gate, and pouring the synthetic resin to the die. Exact accuracy is guaranteed.

A feature of solid cast plastic jigs,

appreciated only by their use, is the fact that they present a continuous surface over which the metal to be assembled is formed, thus providing complete support and ensuring smoothness of form. With large metal jigs, it is often the practice to give support at intervals of 12 to 14 ins., and this can cause wrinkles in the metal during assembly.

Town gives figures from the Timm plant in which plastic jigs are extensively used for the assembly of sheet-metal work, and the savings in time and material are impressive. For example, the following are quoted for one cowl assembly :—

Plastic Jig:

Drawing office time, 8 hours.

Fabrication of plastic jig, including all-metal work in gates and clamps, 125 hours.

Steel Jig:

Drawing office time, 30 hours.

Fabrication, 300 hours.

Further, over 1,000 lb. of steel was saved by resorting to plastic.

The Timm concern use basically the same type of plastic for a wide range of tools, viz., drill jigs, formed router blocks, shaping blocks, checking fixtures, punch jigs, saw jigs, forming dies, and in trim jigs, or practically any jigs involving contours.

The properties of the synthetic resin casting can be varied to some degree by altering the type of filler and/or its quantity, and the Timm Corporation have worked out special formulæ on the basis of practical trials and experience to answer specific needs. One standard established to suit most plastic tooling is an acid-hardening phenol formaldehyde composition which thermosets from the liquid state. The formula given is as under :—

	By weight.
Phenol formaldehyde resin ...	67%
Catalyst	8%
Filler	25%

The filler employed is finely ground walnut-shell flour. In making the mixture, the ingredients are weighed, with every attention given to accuracy. The catalyst is added slowly to the resin and carefully mixed in. The filler is then added and thoroughly mixed. When ready for pouring, the mixture is a dark brown viscous liquid. The plaster mould into which it is to be poured is previously lacquered. Care is taken to ensure complete filling of all parts and puddling to release any entrapped air. Shrinkage during solidification is cared for by means of a retaining form extending above the master component. From the excess in this, material is drawn down to accommodate the shrinkage that occurs progressively with solidification. After setting, the plastic is oven treated, with the time period dependent upon the size and shape of the mould. From two to eight hours is necessary, and the temperature used is in the range 150 to 180 degrees F. The cured casting is removed from the oven, allowed to cool, and then, if necessary, it is sanded with fine paper and mounted on a suitable base.

The size and shape of the plaster mould, its wall thickness, and whether closed, determine the heating period, and the above-quoted times refer to the period after the heat has penetrated the plaster.

The synthetic resin cast in the cured condition is light brown in colour, it is compact and tough, and light in weight. It can be machined; e.g., turned, sawn, buffed, threaded and tapped on the normal woodworking tools.

The Timm Corporation uses plaster moulds quite extensively for casting their plastic jigs, and the following notes appertaining to the plaster technique should be noted:—The reverse plaster cast is made from the mock-up. Size and thickness of plaster are dependent upon the size of the plastic cast intended. The volume of the plaster should not exceed that of the casting. Hemp and steel reinforcements are both used in the plaster cast. Best results are secured if several hours elapse between the moulding of the plaster and spraying it with

lacquer, thus giving it ample opportunity to dry out. Moulds are designed so that the spraying can be easily and effectively accomplished. Three or four coats of high-grade lacquer are employed. For each coat a different colour of lacquer is used, so as to ensure by visual examination that complete coverage has been secured, and each coat is allowed to dry thoroughly before applying the next.

Wooden patterns are made to allow for shrinkage of the synthetic resin, which is uniform for each type and dependent upon the curing time.

Regarding open and closed moulds, the former are used for small and simple casts, and the latter for larger casts, especially when large, flat surfaces that tend to cure in advance of other portions of the cast are involved.

Forming of Transparent Sheets

Before detailing further information upon process and plant used in America for these synthetic resin jigs and fixtures, some notes from another specific procedure are of interest. This, again, is an American development and concerned with the aircraft industry, and it deals with the shaping of methyl methacrylate resin sheet of the glass-clear variety. The raw material is expensive, its accurate forming without deterioration of the surface and of the transparency is an intricate procedure, and, further, it has to be achieved without the setting up of strains that may later cause cracking. The extensive use of these methacrylates in aircraft construction has demanded the development of assured methods of fabricating the sheet to complex shapes with precision and exactitude. The material is too costly, and not in sufficiently free supply, for excessive scrap loss to be tolerable. American researches, virtually carried out on production lines, are of interest in showing how far wood, plaster of Paris, metal, and final cast synthetic resin have each answered the problem, and how finally it is the synthetic resin that has been accepted as giving most general satisfaction in continuous use. Even so, it will be shown that the cast resin tool must be made with close control at all stages if success is to be registered continuously.

Dr. K. J. Leeg, of the Baker Oil Tools Incorporated, Los Angeles, deals with a very special application of the use of plastics for tools in an article entitled, "The Forming of Acrylic Resin Sheets with Plastic Dies," in "The Iron Age," September 9, 1943.

The problem of shaping acrylic resin sheets such as Lucite or Plexiglass has its own special problems, and the use of plastic tools for the purpose has solved many difficulties; but at the same time it does not indicate that such plastic tools necessarily have general application in similar fields. A wide range of materials has been used for making dies for pressing acrylic sheets, and the majority of them have some specific disadvantages or give problems when in use. Particularly when dealing with large components, it is considered that the die material has to possess rather specialized properties. Thus it must have a relatively low coefficient of heat transfer, otherwise the acrylic sheet may be cooled at variable rates, causing strains in the finished component. Also, this coefficient of heat transfer must be constant or, again, lines of strain will develop. The die material must be capable of being used continuously for hot pressing without itself undergoing any physical deterioration, such as gradual softening or the development of embrittlement. Over a period of time it must be dimensionally stable within the limits of tolerance allowed on the component being pressed and in the particular shape involved; the die material must be tough enough to withstand normal handling.

Plaster of Paris and wood have been regarded as the best materials. Plaster of Paris makes a good die, but its life is limited by its tendency to become dehydrated by the heat of the sheet material as it is applied for forming. This promotes chalking or powdering and cracking at the surface of the die. Nevertheless, plaster-of-Paris moulds are easily

made and are inexpensive, and from the economic and practical viewpoints are probably the best that can be employed, especially when comparatively few components are required from one die. When a large number of components are involved, the replacement costs of plaster-of-Paris dies become of greater importance, and make it desirable to consider other materials which then need not be quite so inexpensive.

Forming with Metal and Wooden Dies

Metal dies are justified for long runs and, of course, possess very definite advantages. They are dimensionally quite stable, and mechanically withstand shop handling or even considerable mishandling without change of shape. Advantages include initial cost and high thermal conductivity. If an aluminium die is employed, the cold die at the beginning of a production run tends to remove heat very rapidly from the acrylic sheet, and consequently causes strains in the formed part. As the production run progresses, the temperature of the die very nearly approaches that of the sheet and the forming cycle becomes slower. These disadvantages have been sufficient to limit the use of metal dies to a few instances only.

Hard wood is an important material because it can be readily machined to the desired shapes and, comparatively speaking, is inexpensive. In practice it has proved an excellent material for the forming operation, and generally produces very satisfactory components. The only major disadvantage recorded is that due to the fact that on large dies the separate wooden pieces are glued together, and occasionally when the die operates continuously for long periods, the glue softens and impregnates the cloth covering. In some cases it only comes part way through the cloth. Changes of heat transfer are thereby caused, and strains in the pressed product result. Such strains may not show up until a later stage when the components are in use.

It is comparatively recent that cast resins have been tried as mould materials for acrylic resin sheets. They appear to have the qualities of the ideal material. It is stated that the cost of fabricating a die is usually less than that of a wooden die; this is because the material is easily handled and it can be cast to size and shape in a simple plaster mould. Thus the labour entailed is very little greater than that required for the making of a mould in plaster of Paris itself. In some of the first cast phenolic resin dies the filler for the phenolic resin was 25 per cent. of walnut shell flour, and the results were excellent.

The particular dies referred to were generally small convex shapes, and they were used for forming either by laying the hot acrylic sheet over the contour or by bending the stock over the die and holding it by clamps during the cooling. From the success with these, larger dies were made not only convex but also concave shapes, in which the plastic sheet had to be stretched when formed. In this case a plastic sheet would be blown into the mould, using air pressure, or the mould would be evacuated and the sheet sucked into the cavity. Some very large sections of this type were used, and were at first reported to be satisfactory. With some of them, however, after a short period of service, the concave shapes failed due to cracking. This was caused partly by thermal coefficient of expansion because the hot acrylic sheet heated the surface of the mould while the back of the mould still remained shop temperature, and in consequence a variation in expansion existed between the two surfaces of the mould. The strain produced developed into cracks.

Another cause was the natural shrinkage of the plastic due to ageing, this occurring more rapidly at higher temperatures and therefore to a greater degree on the forming surface of the mould. As this shrinkage developed, greater and greater stresses resulted and more and more cracks appeared.

Certain grades of asbestos can be used as a filler for the cast resin and they produce a material with a thermal coefficient of expansion approximately one-third of

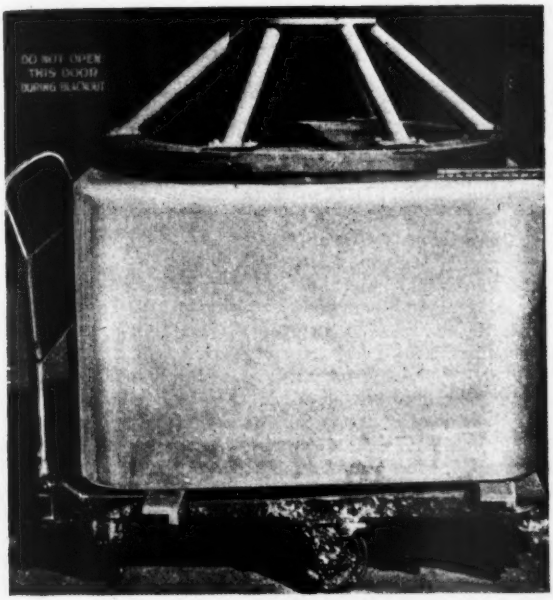


Fig. 1.—A large male and female mould for forming acrylic resin sheet, the female portion being a phenolic casting. The 1-ft. ruler gives an idea of the size of the casting.

large moulds of this type which have been utilized successfully in production. It is stated that plastic of this composition can be relied upon for excellent results wherever intricate contours are encountered. In the making of these plastic dies the following is the general procedure:—

(1) A pattern is

that of walnut shell flour-filled plastic. The rate of ageing shrinkage of the asbestos material is about 25 per cent. of that of the walnut shell type. Moulds using 8 per cent. of asbestos as filler have been in production runs for over six months without any signs of breakdown. Figs. 1 and 2 show two views of

Fig. 2.—An open view of the female mould shown above in Fig. 1.

made of plaster of Paris, wood or clay. The pattern is coated with oil, stearic acid or similar medium, and plaster of Paris is poured over the pattern, thus making a negative of the shape required. Several coats of lacquer are then applied to the negative. A heavy lacquer is essential to avoid sticking of the plastic die to the plaster of Paris. In some cases it is less expensive to make a negative pattern rather than to make a positive pattern and then a negative in plaster of Paris. The negative pattern can be plaster of Paris or wood. When wood is used, the same care must be taken with lacquering in order to avoid sticking.

(2) The volume of the mould is calculated in order to determine weight of plastic required to fill it. Approximate density of the plastic is 1.2, and about 1 lb. is required for 23 cubic ins. of space.

(3) The weights of the constituents for making the plastic are determined on the basis of the final plastic containing 82 per cent. resin, 8 per cent. asbestos and 10 per cent. catalyst.

(4) The ingredients are weighed into separate containers. If necessary, due to the large size of the mould, a number of separate mixes may be made and poured consecutively into the mould with satisfaction, providing that not more than 15 mins. to 20 mins. between pours is allowed. Excellent bond between the various pours is obtained with no apparent variation in physical properties across the junctions. When mixing the plastic, catalyst is added to the resin and sprayed slowly and thoroughly. This is important before the filler is added, because the filler increases the viscosity of the mix, and therefore difficulty of thoroughly incorporating the catalyst results. Uniformity of catalyst is essential for uniformity of setting rate and the avoidance of soft spots. After the resin and catalyst have been thoroughly mixed, the filler is added with slow agitation.

(5) The mixed plastic is then poured into the mould. There is ample time for this because the plastic increases in viscosity relatively slowly. Normally about 30 mins. may elapse between the addition of the catalyst and pouring into the mould. In some cases where fine detail has to be reproduced, it is advisable to brush the plastic into the mould in a similar manner to that adopted when pouring plaster of Paris. It is not generally necessary, however, for the particular class of work in question. When the mould is filled it is left for a few minutes to allow air bubbles to rise before placing in the oven.

(6) The mould is placed in an oven previously controlled to a temperature of 175 degrees F. and baked until cured. The time required varies with the type of material and with the mould thickness. Small castings usually have comparatively thin walls and require about 2 hrs. at 175 degrees F. Extremely large castings may require 8 hrs. to 10 hrs. This time cannot be accelerated by increasing the temperature because boiling may occur.

(7) The cured plastic is removed from the oven and allowed to cool. A slight shrinkage of about 0.0025 in. per linear in. occurs, and consequently the casting will generally thereby free itself from the plaster mould. The heavy coating of lacquer assists this. The cold die is removed from the plaster and is generally then quite ready for use. If the plaster sticks in any spots, it can be removed by scraping.

After any necessary cleaning up, the plastic die is usually covered with felt in the same way that wooden dies are, and it is then ready for the production line. Again, a coating of grease is sometimes used and any fittings can be attached by drilling and tapping.

When necessary, changes in contour can be made by machining. The plastic casts are worked with woodwork tools in much the same way as the hard wood moulds are machined. Wear on tools is a little more severe, but sawing, filing, scraping, drilling and planing can be achieved quite satisfactorily. Final touching up can be done with abrasive paper and polishing.

(To be continued)

World's Industry Employs Plastics

ELECTRICAL

Cam - operated switch entirely of plastics, except for contacts, is shown in "Product Engineering" (Vol. 15, 1944, page 461; July). The switch is permanently assembled by acetone cement and not subjected to corrosion attack. **New and improved model of the "Focallite" hand light** has a formed acrylic plastic lens and a moulded acetate control-switch assembly replacing a die casting. Special features include light-weight butyrate housing. The battery mount is made of vulcanized fibre and extruded cellulose acetate-butyrate tubing. **For masking of parts for hard-chrome plating** a new lacquer has been developed by Michigan Chrome and Chemical Co., Detroit, Mich. It can be applied by brushing, dipping or spraying, and provides a smooth and even coating. It needs only air-drying and adheres perfectly to the surface. After plating it can be peeled off or dissolved; the dielectric strength is excellent ("Machine Tool Blue Book," Vol. 40, 1944, page 330; July). **New vinyl tubing,** which is said to have better heat-endurance characteristics, resistance to oil embrittlement, and resistance to gasoline-benzole than conventional tubings, is being produced by National Varnished Products Corp., Woodbridge, N.Y. Wires insulated with this material may be soldered without special care or technique, and without flow or opening of the tubing near the point of soldering. The tubing remains flexible down to – 80 degrees F. ("Autom. and Aviation Industries," Vol. 91, 1944, page 50; July 1). **Fosterite,** developed recently by Westinghouse Electric and Mfg. Co., is a tough plastic for sealing radar and radio parts against moisture. In the liquid state it is almost as fluid as water, and thus fills completely every space in electrical windings. A special coating form leaves no gaps through which moisture can seep. Another new material, "preformed plastic," is shaped roughly like its finished form, and finally moulded by heat and pressure. Wood fibres locked together with a varnish-like resin give the material a tensile strength of six tons/sq. in. A new process is the stretching of hot plastics. Flat sheets of Micarta 444, after heating to the softening point, may be formed into intricate shapes never before possible with laminated plastics. Westinghouse have also developed a synthetic shellac.

MISCELLANEOUS

Swiss recommendation for standardization of laminated plastics on the basis of paper, cotton weavings and wood has recently been published in "Schweizer Techn. Zeitschrift," Vol. 41, 1944 (pages 61-63). **Pertinent data on the properties of wood** in its application to modern light-weight construction have been collected by G. W. McArd in a comprehensive article ("Mechanical World," Vol. 116, 1944, pages 227-232). Several examples are illustrated; for instance, a light-weight bucket seat constructed entirely of moulded, waterproof plywood, compound curve moulded plywoods, and plywood tubes and girder sections. **A survey of pelleting and preforming processes** is presented by Gilbert-Rolfe, describing

mainly the machines of Manesty, Ltd., Liverpool ("Practical Engineering," Vol. 10, 1944, pages 172-173). **Equation for apparent viscosities of polystyrene for low stresses as a function of absolute temperatures** has been developed by N. M. Foote, and nomograms are given. Lower apparent viscosities occur at higher stresses ("Industr. Engrg. Chemistry," Vol. 36, 1944, pages 244-248; March). **Mechanical data necessary in plastic part design** are discussed by Larson under the headings strength, shock resistance, elasticity, plasticity and hardness. Representative plastic materials are dealt with, and varying service conditions are discussed ("Product Engineering," Vol. 15, 1944, pages 469-472). **Light-weight plywood tubing** represents a new and strong structural material. A tripod made of this material weighs 2.5 lb. and replaces a 10-lb. brass component. The legs telescope and have friction lock to hold them at desired height. A 25-ft. telescoping aerial mast has the same weight and also uses friction locking; structural data and sketches are given. ("Product Engineering," Vol. 15, 1944, pages 489-491; July). **Single-piece industrial goggle,** by Willson Products Inc., fitting over both eyes, is designed to provide high impact strength, and unobstructed vision. It weighs 1¼ oz. and has a replaceable, non-shatterable plastic lens. **Main characteristics of Melamine** plastics together with their chief properties and applications are described by Ch. I. Romieux ("Scientific American," 1944, pages 25-27; July). Special applications are to increase the wet strength of paper during manufacturing, to make textiles creaseproof, to give chintz a semi-permanent glaze, to stiffen mosquito and camouflage netting, to modify polyvinyl butyral and other elastomers. **Absorption of water by synthetic glasses,** in particular plexiglass, has been investigated by U. Athinger ("Journal Suisse d'horlogerie," Vol. 63, 1943, pages 19-23). In particular, the influence of temperature on the velocity of absorption has been studied. Suggestions are made to make watches with plexiglass crystals absolutely waterproof.

New thermoplastic "Cerex" is said to hold its shape and strength in boiling water, and thus may find wide applications for household goods, as it withstands sterilization. At the present time this plastic (produced by Monsanto Chemical Co.) is used for radar, radio and other military electronic equipment. **New plastics** are described by J. Delmonte, the strength of which compares well with that of metal ("Machine Design," Vol. 16, 1944, pages 119-122; August). Seven new plastics of this type are enumerated, i.e., Columbia Resins, Allymer Resins, Laminac, XR 166 31, Plaskon 900, Monsauto 38691, and MR Resins. **Unusual treatment of a fascinating subject** is presented in an article in the June 10 number of "Chemical and Engineering News," entitled "The Chemists' Wonderland," in which Gordon M. Kline, chief of the Bureau's plastics section, takes as his theme the analogies in "the Wonderland and Looking-glass world of Alice's dreams to the realm of high polymer chemistry, typified by the plastics industry of to-day." Although it is essential that the public understand the limitations as well as the astonishing versatility of these new synthetics, a mere listing of present-day types as compared with those available less than 20 years ago makes one agree with the Queen when she told Alice: "Now, here, you see, it takes all the running you can do to keep in the same place. If you want to get somewhere else you must run at least twice as fast as that!" Likewise, there is no difficulty in finding plenty to talk about in applications of plastics under any of the five subjects "of shoes and ships and sealing wax, of cabbages and kings." A partial list of manufacturing groups that are consumers of plastics indicates many other ramifications in the uses for these materials. It is evident that to the animal, vegetable and mineral kingdoms of previous centuries has now been added another—the synthetic kingdom—and that in the list of materials of construction—metal, wood, concrete—there is now a

(Continued on page 476)

High Frequency Solves Moulding Problems

By
LYMAN L. DAWSON
(Vice-President Thermex Division, The Girdler Corporation, Louisville, Kentucky, U.S.A.)

Fig. 1.—Compact arrangement of the Thermex H.F. unit with a semi-automatic moulding press on either side enables one operator to handle all operations of loading and unloading both presses. Plastic preforms are in the drawer of the pre-heating box at the right.

IF you like to hear about one of those so-called impossible jobs which are now being done on a round-the-clock production basis, you will be interested in the success of Diemolding Corporation, in Canastota, New York, in using high-frequency heating to mould aircraft engine ignition distributor heads from a mineral filled melamine compound known as Melmac. The ability of the plastics industry to handle larger and more complicated parts is largely dependent upon its power to heat greater masses of moulding materials rapidly and uniformly. To-day this is achieved most efficiently through the use of high frequency to heat preform.

Because of the low thermal conductivity properties of the compound, the size of the part, the close nesting of a large number of pins, and the complex arrangement of 17 metal inserts, the moulding of Bendix-Scintilla heads for a 12-cylinder aircraft engine was a particularly stubborn job.

To secure proper flow from the transfer chamber into every section of the mould, the 2¼ lb. of preformed Melmac had to be preheated to 250 degrees F. before it was placed in the loading well. Only by a rapid uniform heat could such a mass be heated to the centre without at the same time overheating the surface.

If the core were underheated it could not be made to flow into the cavity without the use of such great pressure that pins were broken or bent, and inserts sheared or moved out of position. If the surface of the preforms were overheated in an attempt to soften the core, the compound began to set, causing equally disastrous results. Following nine months of

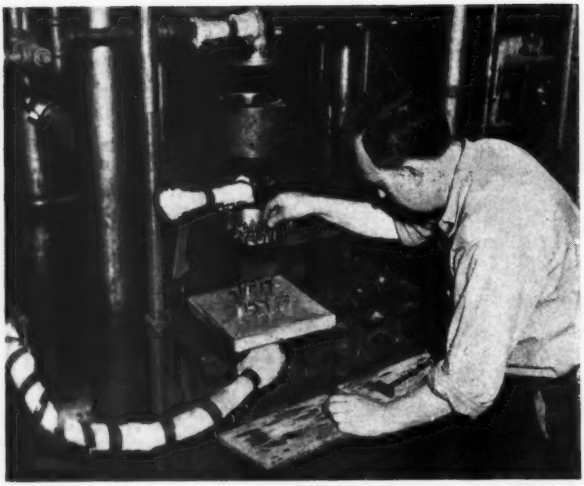


Fig. 2.—Each of the 17 metal inserts is transferred to the proper position in the lower force of the mould.

experimentation in preheating with electric ovens, infra-red work was stopped altogether on this job for several weeks in this particular plant because of inability to reduce the number of rejects.

In March, 1944, Diemolding Corporation installed a Thermex high-frequency dielectric heating unit with enclosed preheater cabinet manufactured by the Girdler Corporation, of Louisville, Kentucky. Within a week the moulding of the Scintilla heads was proceeding on a production basis. By May 1, slight mould changes and other adjustments had been made and the job was proceeding smoothly with the Thermex uniformly heating a steady stream of preforms that kept the two semi-automatic moulding presses operating continuously through the three daily shifts six days a week.

One operator easily handles both presses.

Fig. 1 shows the compact arrangement of the two presses with the high-frequency unit between. The two preforms required to make one distributor head have just been placed in the heating drawer at the right, and the operator is starting the cycle by tuning the machine.

In the Thermex used by Diemolding

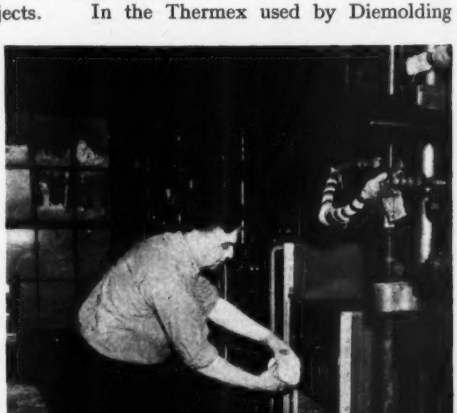


Fig. 3.—The light has just flashed, indicating completion of the four-minute heating cycle, and the operator tests out the plasticity of the preforms by giving them a firm squeeze as he removes them from the drawer.

Corporation the preheating is accomplished by placing the preforms on a removable cast-aluminium drawer which acts as the lower electrode and is readily closed into the preheater cabinet mounted on the side of the generating unit. This generator produces a high-frequency power which passes directly through the preforms placed between the two electrodes. The dielectric loss factor of the material and the passage of the electrical power produces the heat within the preforms themselves.

The top electrode, which is also cast aluminium, is adjustable, its position being indicated on the outside of the cabinet by a calibrated dial. The upper electrode is generally positioned to provide an air-gap above the preforms so the drawer can be freely moved. While the heating process is taking place, the operator is setting up the 17 metal inserts on an assembly board from which he transfers them to keyed positions in the lower mould force of one of his presses (Fig. 2).

Fig. 4.—After three minutes of mould closing and five minutes of setting-up, the finished head is removed from the mould and the operator is ready to repeat the process.

For this particular moulding job two preforms with a total weight of 2¼ lb. are placed in the drawer. After four minutes between the electrodes the Melmac has been heated to 250 degrees and has reached a point of plasticity where the operator can push a finger and thumb into it (Fig. 3), much as he might do with a ball of putty. Opening the preheater drawer automatically opens the circuit and eliminates all danger to the operator. Any resumption of the heating involves the use of the starter button control on the instrument panel.

Because there is such close difference between the softening point, flow point, and setting up point of the Melmac, a minimum period must elapse between the time when the operator removes the preforms from the drawer and the time when he places them in the loading well of his press. In this steam-heated well the heating process is continued throughout the three-minute press-closing time during which the mould plunger is compressing the Melmac and transferring it into the mould cavity.

With a pressure of 70 tons being exerted on the 12-in. ram, the compound which flows freely between 290 degrees

and 300 degrees is forced through the two gates into the heated cavity. Here it is held under pressure for five minutes more before an indicating light signals the operator that the thermosetting reaction which hardens the piece is completed, and that the finished head is ready for removing from the mould (Fig. 4). It is believed that the gates being used in moulding the Bendix-Scintilla heads are the largest openings in transfer moulding.

A white thermosetting compound, asbestos-filled melamine has high dielectric properties and cures into a light greyish-brown product capable of withstanding 25,000 volts for three minutes and having a flexural strength of 10,000 lb. Its specific gravity is 1.78 and in the moisture resistance test it must show it can be submerged in water at 25 degrees C. for 24 hrs. and still have less than 2 per cent. moisture absorption. Rejects on the Scintilla heads before installation of Thermex high-frequency equipment often ran as high as 30 per cent. to 50 per cent. of the day's output. Once the preforms were heated with high-frequency the percentage of rejects dropped below 5 per cent. The complete cycle for moulding one of these heads is 12 mins. With an allowance of time out for lunch and two short recess periods, production is now 35 heads per press in an 8-hr. shift.

Production prior to installation of the Thermex was considerably less than half this amount.

WORLD'S INDUSTRY EMPLOYS PLASTICS

(Contd. from p. 472)

new name—plastics. A review of the manifold military applications of plastics forms a most interesting portion of the article. Future applications, as we may become familiar with them in the "Looking-glass" world of to-morrow, are shown to require almost a belief in the impossible. With this approach, not only six but dozens of useful and beautiful things are visualized as contributions of plastics to better living. A scratch-resistant, nonfragile, heat-stable, weatherproof, transparent product—the result of the discovery by some chemist of the proper co-polymer of styrene, methyl methacrylate, or other relatively simple compound with a cross-linking, elastomeric monomer—can be expected. The low-pressure moulding process developed during the present war to turn out helmet liners, aircraft and radio parts, small boats and binocular cases may give us compact bath and kitchen units, light but strong furniture, economical two-seater utility automobiles, and the light, tough, sound-absorbing structure of the family helicopter. "One thing is certain: The war applications of plastics have been amazing in scope but drab in aspect. The plastics of to-morrow will herald the return of spring to a colour-starved world." **Help in solution of bearing design problems** is provided by a test rig at Westinghouse Research Laboratories, whereby bearing and journal are made of clear Lucite acrylic plastic. Pigmented oil indicates immediately the effectiveness of the lubrication. ("Product Engineering," Vol. 15, 1944, page 566). **The U.S.S.R. has been granted rights to produce Neoprene** at the request of the American Government. Du Pont grants a free licence to Allied countries during the war, and this has now been extended to Russia, which has already been receiving large quantities of American Neoprene products under lend-lease. Compensation in the post-war period will be fixed according to the volume of Russian production. ("Product Engineering," Vol. 15, 1944, p. 566, Aug.). **Portable indicating comparator** has a handle of low-thermal conductivity moulded Tenite to prevent transmission of heat from the operator's hand. As a further safeguard to accuracy, the plastic handle is so designed that the thumb will not touch the indicator ("Machine Design," Vol. 16, 1944, p. 156, August).

Protection of Radio Components for the Tropics

How Transformers, Chokes and Coils are Treated to Meet Modern Requirements

By WALTER J. TUCKER

DAMP atmospheric conditions affect the efficiency of all electrical and radio apparatus very seriously, and adequate steps have to be taken to prevent moisture condensing on, or being absorbed by, the insulating material employed. This is particularly important with regard to close-wound coils such as are used for transformers and chokes.

The wire used is usually enamelled, but in some cases it is covered with silk, cotton, or both. Enamel is moisture resistant, but it is not always advisable to use it alone because it can be affected by chemical fumes and solvents, and it is also liable to be cracked or crazed by the stresses set up in the coil winding operations. Silk and cotton, although good insulators when perfectly dry, are readily absorbent. Also, moisture condensing between the layers of wire and adjacent turns of the winding can be quite easily trapped and eventually absorbed by the insulating medium. Often this is the cause of corrosion on the iron stampings used for the core.

To obviate the dangers which arise when moisture is allowed to condensate or chemical fumes are allowed to penetrate into such windings it has become customary to completely impregnate or varnish the wound coil with a suitable insulating and moisture-resistant compound.

To meet modern requirements, such compounds, apart from being good insulators, capable of withstanding the potential differences existing between separate turns of the winding, must also be stable over a wide temperature range. To meet a tropical specification they should not soften at temperatures up to 80 degrees C., and should not become brittle or break up at temperatures as low as −40 degrees C. Nevertheless, in order that impregnating can be carried out efficiently, and to ensure that the compound reaches all the small spaces right inside the coil, it must flow freely at a temperature below that which is likely to damage the wire covering. It is desirable that it has a very marked flow point, so that a minimum temperature change will transform it from the solid state into a free-running liquid. When it resets, the compound should be impervious to moisture penetration and unaffected by temperature within the range stated.

Obviously, such a requirement can only be met adequately by a compound which is subject to chemical changes during the processing stages, so that its final properties are different from those possessed at the application stage.

When low-frequency coils are being dealt with the only electrical requirements are high dielectric strength and good insulation resistance, but in high-frequency circuits, compounds with a low loss factor must be used, as otherwise the impregnating medium will constitute a leakage path for high-frequency currents.

Types of Compound Available

Research to reproduce the ideal compound has gone on for many years and at present numerous types are available. These may be broadly classified under three headings—waxes, air-drying varnishes containing natural drying oils and

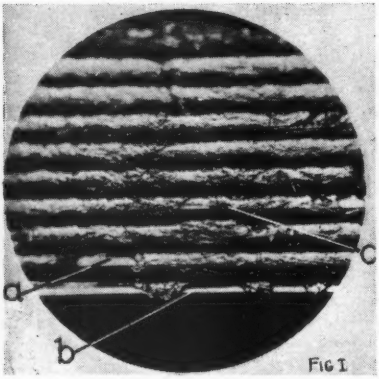


FIG I

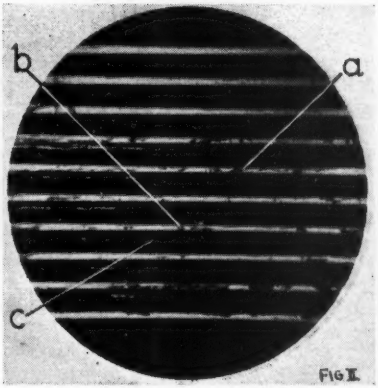


FIG II

Fig. 1 (left).—This microphotograph illustrates the middle layer of a coil wound with 40 s.w.g. enamelled wire, impregnated with a modern synthetic resin varnish, having 80%–90% solid content, and no free phenol. The coil has been correctly processed to dry out all solvents. The winding was interleaved with paper, and marks where this has adhered can be seen quite clearly. At points "a," "b" and "c," the thickness of the film of varnish is shown in comparison with the diameter of the wire. Fig. 2 (right).—This illustration shows a similar coil impregnated with a thin varnish (50% solid content) and exhibiting at "a" and "b," signs of attack on the enamel and wire by trapped solvent and free phenol. As the photograph shows, the varnish did not adhere to the wire so well as that shown in Fig. 1, and "gussets" of varnish can be seen at "c." *(Courtesy: Igranic, Ltd.)*

resins, and varnishes with a synthetic-resin base, which is dried off by evaporation and heat polymerization.

All three types are widely used, but the following points should be noted.

Waxes at present available are not very satisfactory over a wide temperature range and do not offer the same degree of mechanical protection as the varnishes.

Air-drying varnishes contain solvents which dry off upon exposure to air. If it were possible to ensure that these solvents were completely dried off, such varnishes would offer excellent protection, but great care must be taken to ensure that quantities of the solvent are not trapped inside the coil. It is quite easy for this to happen, because after the coils have been dipped the varnish on the outside will dry first and the drying process will continue inwards. There is, therefore, no way of escape for the solvent from the varnish which has penetrated right inside the coil. It is recognized that it may be impossible to guarantee that no solvent has been trapped in this manner, and the modern tendency is for varnishes to be mixed with solvents which have no effect on the enamel or cotton covering of the wire.

The synthetic-resin varnishes, which are used far more extensively than any other type, also suffer from the disadvantage of possessing solvents which must be dried off completely, but they are not dependent on air oxidization as a hardening and drying process. A coil dipped in a synthetic resin of the thermo-setting type is subjected to a heating cycle similar to that applied to a compound for moulding purposes, and the chemical action which takes place is also similar. It has been proved to be much easier to ensure that a synthetic-resin-varnished coil is dried off right through to the core than one dipped in an air-drying varnish of the ordinary type, although in all cases the depth of the winding is the governing factor. The adoption of high-frequency heating has

also helped in this respect. When this method of heating is applied, heat is generated at the centre of the core first; consequently, the inner layers of varnish dry off and release their solvents before the outer layers have hardened.

To the same extent as it is essential to avoid trapping solvents from the impregnating compounds, so it is equally as important to be sure that no moisture is trapped inside the coil after the impregnating process is completed. It has, therefore, become standard practice to pre-heat the coils and carry out the dipping process in a vacuum. A typical cycle of operations for impregnating a coil in synthetic-resin varnish is shown in diagram form in Fig. 3 and is described below.

Impregnating Process

The coils are first dried thoroughly in an oven or current of hot air at a minimum of 110 degrees C. for anything from 2 to 24 hours, according to size. They are then transferred to the impregnating plant and a vacuum is maintained in the tank for not less than 45 minutes. Cold varnish is admitted until the coils are covered. The next step is to re-admit air and compress it to between 60 and 80 lb. per sq. in., under which conditions the coils are left for a period, the duration depending on the size of the coil. This may vary between 30 minutes and one hour. The varnish is then drawn off and the coils are left to drain. They are then transferred to a hot vacuum tank wherein a temperature of between 70 and 80 degrees C. is maintained for a few hours and a circulating atmosphere is kept up through a solvent condenser. This is to dry off the solvents. After this operation the temperature is raised to cause the resin to polymerize.

Tests for insulation resistance are then made. The figure usually required is 25 megohms minimum between coils, and if the core is fitted before impregnating the same insulation resistance is required between the coils and the core.

Dip Coating

It is often found that one application of the impregnant is not enough to enable the insulation resistance figure to be maintained up to the standard required in first-grade work such as is suitable for tropical use and, therefore, a second application is called for. This is carried out in much the same manner.

This second coat, or, alternatively, a dip coat, is a definite requirement if specifications for aircraft apparatus are to be complied with, and most manufacturers have adopted the dip coat as standard practice.

A good dip-coating material should be stable over a range of temperature from +70 degrees C. to −40 degrees C. and must also be resistant to moisture and manhandling. In addition, its heat dissipation properties must be such that it does not shut in the heat which may be generated in the transformer or chokes. This is important, because the dip coat is usually thick and covers the coil completely.

There are various dip-coating compounds available, most of them of the bituminous type, and the process is a simple one of dipping the pre-heated coil into the molten compound or solution.

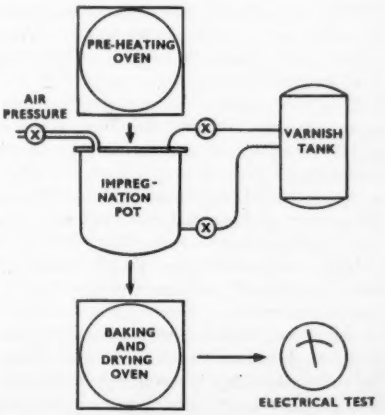


Fig. 3.—Impregnation plant.

Special waxes have been developed for coils which are intended to withstand particularly arduous conditions of service and recently experiments have been carried out with a polyvinyl-chloride paste, which is cast around the completely assembled transformer or choke.

Two important requirements of a dip coat are that it should adhere to the surfaces which it has enveloped and that no expansion or shrinkage, which would cause it to break away from these surfaces, should take place with changes of temperature or after a period of ageing. If such breakaways do occur, a moisture trap between the outer surface of the coil and the inner surface of the compound is created. Moisture trapped in this manner will lower the insulation resistance across windings and terminal wires.

Coils for High-frequency Circuits

Special waxes have been developed for treating coils designed to carry high-frequency currents. In addition to possessing all the normally desirable properties, they must also possess a very low loss factor and a dielectric constant of not more than 4.5 at frequencies up to 20 megacycles.

Surface resistivity should be at least 10^6 megohms per cm^2. Volume resistivity 10^7 megohms per cm^3.

The wax should not melt at temperatures below 75 degrees C. and no cracking should occur when the wax is exposed to −40 degrees C.

The wax should be resistant to moisture penetration and should have no injurious effect on the enamel or fabric covering of the wire.

A number of such waxes exist and have been approved for tropical impregnation and dipping specifications.

The composition of these types of wax varies with each proprietary brand, but paraffin wax is used as a base for many types. Substances such as chlorinated naphthalene, melamine and other recently developed synthetic varnishes and liquids are being incorporated in these compounds to improve temperature range and stability characteristics, but little precise data has been released at the present time.

Condensers and Other Components

Where it is intended that they be used in tropical conditions or in circumstances involving exposure to extremes of temperature, condensers and other radio components are dipped in waxes and sealing compounds. This sealing is very important having regard to the small capacities involved and the effect on such capacities of moisture penetration. The usual process is to manufacture the condensers as watertight as possible, and then cover them with a coating of wax by a simple dipping process.

For small condensers for use in high-frequency circuits, the practice of moulding the condenser plates and dielectric in polythene is being extensively adopted. This can be done on small injection moulding machines, the only objection being the softening and deformation temperature of this plastic. Flat section, block-type condensers have been moulded in Bakelite housings for some time, but the popular tubular type of condenser is still "tropicalized" by the dipping process. It can be said that it is simply an economic question as to whether such condensers are moulded or not. The dipping process has proved very satisfactory and totally enclosed moulded condensers will only become universal when the cost of such a product is reduced to a level competitive with the rolled and, subsequently, dipped tubular construction. Plastics, however, are playing an increasingly important part in the make-up of protective waxes and coatings. There is a great future for melamine in this sphere, and polyvinyl chloride also is being experimented with as a moulding compound for totally enclosing radio condensers.

Flame-resistant Nitrocellulose

Hercules Powder Company announce the production of a flame-resistant nitrocellulose compound by the incorporation of tricresyl phosphate and magnesium ammonium phosphate.

PROBLEMS OF CREEPING PATH IN PLASTICS*

By B. FRISCHMUTH

THE non-conducting properties of plastic materials are in general excellent, and the testing and evaluating of their electrical properties is a prerogative for their application in electrical engineering. Amongst the more important electrical properties for which the plastic part has to be tested in order to determine that it corresponds to the necessary conditions, such as penetration and surface resistivity, dielectric constant and break-down voltage, examination for creeping-path strength has a special place.

Whereas the first-mentioned properties are measured by exactly defined methods which allow the behaviour of the finished product to be judged, no suitable testing method has, hitherto, been found for testing the creeping-path resistance or strength. This can be explained partly by the fact that, in spite of many investigations, the nature of this property is not yet clear from the theoretical point of view; it is, therefore, difficult to devise a laboratory test which will subject a part to the same stress as will occur in service under creeping-current conditions.

Numerous investigations which deal with this problem have been carried out from both the theoretical and the practical side, and many interesting tests have contributed their part to clarify a very complicated situation; however, the mechanism of the formation of creeping paths is not yet fully clear.

A survey of recently published investigations will now be given, but, first, a definition of what is understood by "creeping path" seems to be necessary. Experience has shown that many moulded materials have a tendency to creeping-path formation under the influence of time and the surrounding atmosphere, the tendency varying with their chemical composition. Relatively high electrical resistance is then momentarily reduced to such an extent that a conducting connection between components under current is produced, which may lead to breakdown or destruction of the insulator.

Frequently, the small current loss caused by the normally imperfect insulation has been designated as "creeping current." Modern views understand "creeping current" to be only that current which occurs suddenly, whereby surface resistivity or the insulating power is abruptly reduced under external influences. A connection between surface resistivity and the tendency to form creeping path could not be ascertained.

Disruptive and Slow Discharges

On principle, a distinction must be made between two types of electrical load which can lead to the formation of a creeping path. The first is the direct action of an intermittent spark, or the passing over of a spark between parts under current. Through the resultant thermal action the surface may be changed to such an extent as to give rise to a creeping path. In the second case, differences in electric potential at the surface, or internally, are sufficient to form a creeping path without causing a spark or arc. Only when the creeping path occurs as a secondary phenomenon may a spark be formed. Change in the nature of the surface can be caused by a deposit of dust or moisture and by chemical influences.

With reference to a testing method presenting possibilities for the formation of creeping paths, it is necessary not only to determine the resistance to this taking place but, also, to know something about

* Schweizer Archiv f. Angewandte Technik, etc. Vol. 10, 1944, pp. 156-160.

the safety of the material in question. Resistance to the formation of a creeping path is understood as an inherent property of a material similar, for example, to tensile strength. Safety against creeping-path formation, however, is a factor correlated with a finished product, as in this case design is also of significance.

The analogous mechanical example is the breaking strength of a mechanical component. It may be mentioned in advance that, in spite of the standardized methods adopted in some countries, no satisfactory method has yet been developed from which conclusions with reference to safety against the formation of a creeping path can be deduced from the creeping-path resistance.

As creeping paths exhibiting constant conductivity occur relatively seldom, necessary conditions have to be simulated in the laboratory. Another suggestion is to investigate the theoretical problem of electric conductivity in plastics, and then to use the findings to elucidate the special case of conduction of current along the surface.

Ionic Conductivity Demonstrated

According to Boening, all plastics have an internal conductivity which is based on the ionic movement. The ions can migrate along the internal boundaries. Such phenomena have been made visible in experiments. Vieweg and Klingelhöffer used silver electrodes, which were incorporated into a cast resin. When a direct current at 1,000 volts was passed, the silver migrated slowly from the anode into the plastic, small bubbles being formed at the cathode. The latter fact is explained by electro-osmotic phenomena. The current path became visible as a reddish-brown streak. The resistance between the electrodes drops somewhat at the beginning, but later on increases considerably, the rise being more rapid the higher the applied potential.

The same authors found in a later investigation a clearly observable migration of metallic ions in polyvinyl chloride. The plastic formed in this case the anode in solutions of silver and lead nitrates, the cathode being formed by a part of the containing vessel, which was provided with a metal or graphite film. The boundary of the penetration zone is sharp in the case of nitrate of silver, and jagged in the case of nitrate of lead; the difference is caused by the varying conductivity of the penetration zones in relation to the metallic salt concerned.

A practical use of this system of embedding metallic conductors has not yet been tried out; there is, however, a possibility of increasing current density and conductivity, say, by a further treatment of the surface by the application of a metallic film. These are all problems open for further investigation.

The authors conclude that all plastics can be classified into two groups, i.e., those with an inherent conductivity and others with electric conductivity due to the migration of ions from foreign bodies along the internal boundaries.

Stationary and Variable Conductivities

According to Houwink, in cured phenolic resin there are formed internal boundaries, which cause a loosening of the bond, thus a migration of ions seems to become possible. With softer materials the movement of the molecules is so great that no cavities can remain, hence the migration of ions, as explained above, can occur.

As, however, conductivity can be experimentally demonstrated in plastics, this is explained by diffusion processes. Houwink disagrees with the assumption of inherent conductivity in plastics as such, and considers the phenomenon to be due, instead, to impurities caused by imperfect polymerization. More detailed investigation seems necessary to strengthen the theoretical views and to obtain a clear picture of the electrical properties of plastics in general.

In the case of the creeping-current problem the relations are still more complicated, as they do not represent a stationary condition, as is more or less the case with respect to normal conductivity. Testing devices, however, become simpler, as these surface phenomena can

be readily observed from the outside. Furthermore, from observations on surface conductivity, it may be possible to draw conclusions as to what is happening inside the mass.

Promoting Surface Change

Very extended investigations on the variations of surfaces due to electrical loads have been published by Staeger and Siegfried. With thin sections of pure resins, there was observed the formation of a creeping path due to the application of a direct current at a potential of 1,500 v. for a long period. These investigators traced its formation to the presence of electrolytes at the internal boundaries and considered the whole problem as a corrosion phenomenon, as the tests showed a strong dependency on the amount of moisture present. The transition from pure surface current to creeping path is not continuous, but occurs in steps, whereby, at zones of higher concentration of electrolyte, good conducting "cells" can be formed, which, by progressive corrosion, can link up to form a coherent path.

According to this theory, it might be expected that the determination of surface resistance would not give information about the inclination of a material to form creeping paths, a conclusion clearly confirmed by all experiments; hence careful workers refer only to surface resistance determined in the usual way. However, it is possible that, by some special technique, a connection between surface resistance and resistance against creeping may be established.

Some testing methods presume that such a connection exists. The surface resistance of plastics has been determined by careful measurements, and permit a distinction between "through current" and "surface current." This is of fundamental importance for accurate measurement. The considerable drop in resistance for higher moisture contents in the surrounding atmosphere seems to support the assumption of "cells" of increased conductivity. Remarkable, too, is the *increase* in resistance sometimes observed for higher relative humidity, if the surface be subjected to high p.d. for long periods; conductivity appears to develop heat and to dry the conducting bridges between the sections of lower resistance. Staeger and his collaborators, however, observed under these conditions a drop in resistance. They stored thin sections of various phenoplasts (treated with ether) in an atmosphere of 90 per cent. relative humidity for a period of 200 days, exposing them at the same time to a direct current of 2,500 v. between knife edges at a distance of 5 mm. The observed drop in resistance could not be measured accurately and should be treated with caution. A connection between the formation of creeping paths and surface resistance could not be observed.

Exciting Factors Summarized

As causes for the production of a creeping current Pfestorf and Richter give the following:—(1) A current path can be caused by a high-tension discharge between two electrodes. The sparking causes a thermal stress, and burns in the material occasion a conducting path. (2) The creeping path can arise with a low-tension discharge, when an interrupted spark (say from a rotary switch) causes the thermal stress. (3) Without the primary generation of a spark or light arc, a creeping path arises only as a result of change in the surface conductivity through accumulation of solid and fluid materials, or through chemical change at the surface.

It would seem necessary, here, to note that the general expression "chemical change at the surface" may, in itself, in turn, imply the operation of numerous secondary factors. In the case of hard rubbers, it is not unknown for surface oxidation to occur under the influence of light or ozone, with the resulting production of apparently hygroscopic acid products. Plastics for electrical purposes, whilst not prone to this elementary type of breakdown, may, nevertheless, under sufficiently adverse conditions, react in an analogous manner.

(To be continued)

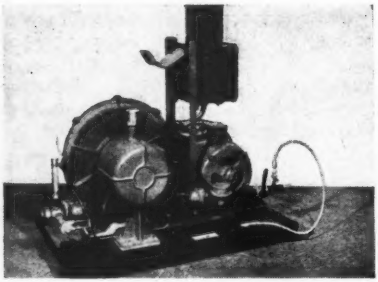
PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

THE CYCLONE GENERATOR.—One of the most recent developments in the application of town gas to paint finishes which deserves serious attention is the Cyclone Generator (B.P. App. No. 10326/43, etc.), used in the " Plastoglaze " process developed by Plastic Spray, Ltd., 3, Vere Street, London, W.1.

The process of stoving paint finishes on large objects provides serious difficulties, both with infra-red and the normal convection oven, as an oven capable of taking the largest object must be installed. This new development entirely overcomes these difficulties.

The paint is sprayed in the normal way



and dried in a few minutes by the application of hot air containing products of combustion at a temperature of 350 degrees F. The unit designed for this purpose had to be mobile and the air as free as possible from dust. A brief description of the units available is given by the following output and consumption figures.

(a) Cyclone Generator No. 2/S.—Stationary unit. Output: 10,000 cubic ft. of hot gases per hour. Consumption: 0.45 therms of town gas per hour.

(b) Cyclone Generator No. 2/M.—Mobile unit. Equipped with wheels and 20 ft. of asbestos-lagged flexible metal hose, round outlet and handle. Output and consumption as for model No. 2/S.

(c) Cyclone Generator No. 3/S.—Stationary unit. Output: 30,000 cubic ft. of hot gases per hour. Consumption: 1.25 therms of town gas per hour.

(d) Cyclone Generator No. 3/M.—Mobile unit. Equipped with wheels, 60 ft. of asbestos-lagged flexible metal hose, four round outlets and handles. Output and consumption as for model No. 3/S.

The manufacturers can quote for special outlets to meet individual requirements. If gas and electricity supplies are not available, special units are obtainable. If gas only is available, the units can be fitted with a petrol motor.

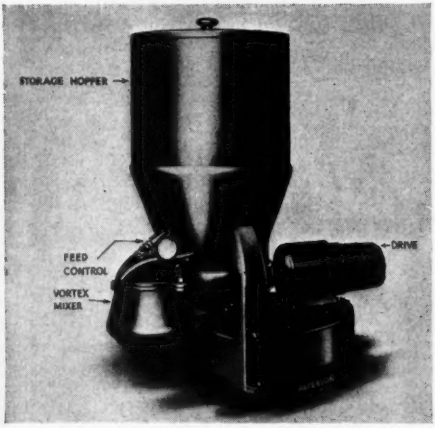
The advantages of this system for very large surfaces or a heterogenous collection of objects is obvious. The finish obtained is equal to that produced with synthetic paints stoved by infra-red or convection methods and the constitution of the varnish coupled with the high rate of air change gives a wide latitude of safety and freedom from pinholes.

The " Plastoglaze " process is patented by Plastic Spray, Ltd., who grant a free licence for its use with the units sold.

The Cyclone Generator provides one of the most compact and efficient air heaters available, and as such has a number of uses other than the specialized paint-drying for which it was designed. It is essentially a portable unit air heater with thermostatic control. During its development in conjunction with The Gas Light and Coke Co. Industrial Centre at Watson House, experiments have been made on drying processes, and particularly on the removal of water from metal objects after hydraulic test. The application of the unit to the so-called false stoving of aeroplane parts is particularly important.

Further details can be obtained direct from Plastic Spray, Ltd., 3, Vere Street, London, W.1, or from the G.L.C.C. Centre, Watson House.

DRY CHEMICAL FEEDERS.—A valuable machine is the dry chemical feeder, and in this connection the latest principles are well represented by the " Paterson " feeder, a production of the Paterson Engineering Co., Ltd., of London (Windsor House, Kingsway, W.C.2). This is suitable for the continuous feeding at any desired speed, varied almost instantly merely by rotation of a small knob, of a wide range of granular material. Although the machine is used to a considerable extent for water treatment,



including feed-water, in which, of course, the firm are well-known specialists, supplying material such as hydrated lime, sulphate of alumina, soda ash, sodium aluminate, ammonium sulphate, activated carbon, chalk, sulphate of iron, copper sulphate, and sodium chloride (common salt), it is suitable for almost any granular product.

Essentially it consists of a sheet-metal cylindrical storage hopper with cover, and a substantial base with self-contained enclosed electric motor and a vortex mixer delivering the material, after thorough mixing with water, if this is desired, from a pipe at the bottom, and included is a feed control mechanism, to vary the amount of the feed from the hopper mixer. The machine is in two sizes, Nos. 1 and 2, the overall height from the ground level to the top of the hopper being 3 ft. 2 ins.-4 ft. respectively, whilst in plan view the overall dimensions are 2 ft. 3 ins.-2 ft. 11 ins. and 2 ft. 3 ins.-3 ft. Further, the machine can be fitted with an additional large storage hopper for the granulated material feeding into the machine hopper, whilst the minimum and maximum delivery depends, of course, upon the nature of the material.

The range of any particular machine is approximately 40:1, whilst in the two standard sizes the hopper capacities are 2.5-5 cubic ft. respectively, and the self-contained electric motors are ¼ h.p. and ½ h.p., the gross weight also of the two sizes being 350 lb. and 500 lb. In the case of hydrated lime, for example, which weighs 35 lb. per cubic ft., the size 1 feeder will deliver anything from 0.15-150 lb. per hour, whilst the No. 2 feeder has a range of 0.5-500 lb. per hour.

H.F. SEAM-WELDING MACHINE.—The latest development in seam-welding machines of the high-frequency type for welding thermoplastics (P.V.C., etc.) has now been put on the market by Diaplastics, Ltd. (proprietors: Arc Manufacturing Co., Ltd.). Readers may remember that the general type was described by H. P. Zade in "Plastics," March, 1944, p. 100. The machine, which welds thin plastic sheets up to 1-32 in. and plastic-impregnated fabrics is self-contained and operates from a 230-volt single-phase 50-cycle 15-amperes supply. The high-frequency generator is of the self-oscillator type with a maximum output of 250 watts at 50 megacycles. Tuning of the generator to the job to be welded is effected by means of a variable-tuning transformer. The generator is fully screened and is provided with a suppressor to prevent back-feeding of H.F. into the mains.

Welding speeds between one and six feet per minute can be obtained by means of an

infinitely variable speed control. Welding rollers are easily interchangeable, and several widths and profiles can be used. Welding pressure is adjusted by a micrometer head which controls the spring loading of the top roller. Full details regarding these machines, which are licensed out to users, are obtained from Diaplastics, Ltd., 52a, Goldhawk Road, London, W.12.

EBONESTOS INDUSTRIES, LTD.—At the annual general meeting of the British Homophone Co., Ltd., Sir Herbert Morgan stated that their wholly owned subsidiary Ebonestos Industries, Ltd., showed a net profit of £31,433 for the period ending March 31, 1944, compared with £25,574. He stated that the time is approaching when there will be a falling off in plastic work used for war purposes. The directors were fully alive to the necessity for planning so that the change-over from war to peace production could be effected in the shortest possible time. There was evidence that the plastics industry would play a full share in supplying the materials wanted in the coming years, but one must emphasize, he said, that for post-war requirements competition will be keen. There were many newcomers to the industry and it is hoped that reckless price-cutting will be avoided.

U.D.A. (PLASTICS), LTD., of Bristol, have acquired the services as works manager of Mr. G. P. Linklater, the late manager of Messrs. E. K. Cole, Ltd., of Southend.

THE MINISTER OF FUEL AND POWER has made a new Direction and Order amending the existing Control of Fuel (No. 3) Order, 1942, General Direction (Central Heating and Hot Water Plants) No. 1.—S.R. and O. 1943, No. 451, and the Control of Fuel (Restriction of Heating) Order, 1944.—S.R. and O. 1944, No. 454.

The effect of the new regulations, which are operative for 1944 only, is to allow the use of any form of heating on and after October 8 in Scotland and Northern England, which includes the counties of Northumberland, Durham, Yorkshire, Cumberland, Westmorland, Lancashire, and Cheshire, and the High Peak of Derbyshire (the Boroughs of Buxton and Glossop, the New Mills Urban District, and Chapel-en-le-Frith Rural District). In the remainder of England and in Wales heating will be permitted on and after October 15, 1944. Until these dates the restrictions on central heating and on alternative forms of heating in controlled premises remain in operation.

INSTITUTE OF THE PLASTICS INDUSTRY.—The first meeting of the London Section during the 1944-5 Session will take place on Wednesday, October 11, 1944, at the Waldorf Hotel, Aldwych, W.C.2. This will be a luncheon meeting, followed by an address by Mr. C. F. Merriam, chairman of the British Xylonite Co., Ltd. Application for tickets for the luncheon must be accompanied by 10s. for each ticket.

Midland Section

Midland Section (Hon. Sec.: C. P. Hughes, c/o Bakelite, Ltd., 1, Kineton Green Road, Olton, Birmingham). The following meetings will take place in November:—

Monday, November 6, 1944.—Luncheon meeting at "Crown and Cushion," Perry Barr, Birmingham, 22, commencing 12.30 p.m., for lunch at 1 p.m. N. G. Lancaster, Esq. (Messrs. Fisher and Ludlow, Ltd.) has kindly consented to give a short talk. Applications for tickets should be made direct to the Hon. Sec. immediately.

Friday, November 17, 1944.—Lecture meeting, commencing 6.30 p.m., at The James Watt Memorial Institute, Great Charles Street, Birmingham, 3, when a paper entitled "Testing of Insulating Materials" will be read jointly by Messrs. E. L. Hoyle (General Electric Co., Ltd.) and F. Meyer (Sterling Varnish Co.). Refreshments served from 5.30 p.m.

Presentation to Mr. N. J. L. Megson

Following the committee meeting of the Plastics Group in London, on September 19, a brief, informal, but nevertheless sincere, ceremony marked the retirement of **Mr. N. J. L. Megson** from the office of hon. secretary after seven years' service. Mr. Austin Lowe, a former hon. secretary, on behalf of the committee, presented Mr. Megson with a Georgian silver bowl, cut-glass decanter and glasses, paying tribute to his work for the Group, particularly during the difficult war years. Mr. Megson is now vice-chairman, and Dr. S. H. Bell succeeds him as hon. secretary.

Personal

Mr. A. J. Gibson has moved to 7, Whitehead's Grove, Chelsea, London, S.W.3. From September 28 all letters and mail should be sent to that address.

Correction

In the September issue of "Plastics," it is regretted that an error was made in the name of Mr. N. H. Chamberlain's company. This was given as "Celluloid, Ltd," which, of course, should have been "Cellomold, Ltd."

UREA FORMALDEHYDE

This thermosetting plastic material is available in the form of resins and moulding powders. The resins have wide applications as cements and glues and provide strong waterproof joints that resist attack by moulds or insect pests. By mixing the resin with woodflour or paper pulp, moulding powders are produced from which attractive mouldings can be made in an extensive range of translucent or opaque colours. These coloured mouldings are fast to light and have good mechanical strength.

"Mouldrite" is the trade name of the urea formaldehyde resins and moulding powders made by I.C.I. Information concerning these and their many other plastic materials will be supplied on request.

ICI

IMPERIAL CHEMICAL INDUSTRIES LTD.
LONDON, S.W.1

P.136a

FROM FINE FINISHES

The well-known CELLON range of products has been built up largely by the rapidity with which the CELLON technicians appreciate the importance of new innovations and new industries.

The rapid increase in the use of Plastics presents intricate but surmountable problems and, in fact, CELLON Synthetic Finishes and Thermo-Plastic Adhesives have already been devised and are in use for numerous special purposes.

CONSULT CELLON on all problems of finishing or jointing materials, and let them give you the benefit of their experience in this and other fields. The address is Richmond Road, Kingston-on-Thames, Surrey. Telephone: Kingston 1234 (5 lines).

TO FINE ADHESIVES

CELLON

A Cellon product

The final word in finishes...

CELLON
CERRIC CERRUX

CVS-531

Planned Mould Maintenance Service Aids Economical Production

Part VI

By W. M. HALLIDAY

Continuing last month's study of the preferred types of design of injection mould component members to ensure effective trouble-free operation.

Movable Core Constructions

MOVABLE coring elements will be required in those cases where the injected moulded article must be so formed with either bossed or recessed portions lying along a plane not exactly parallel to the normal axis of the ejection stroke of moulds; or in those cases where the finished part is stripped from a large core member instead of being ejected therefrom by means of push pin type of ejectors.

Such core members may be of non-circular cross-section and may be arranged to draw at a wide angle to the line of mould block opening, but in order to simplify construction of the core-withdrawing mechanism it is always advisable to endeavour to locate it at right angles to the parting-line of the mould, and preferably in the same plane.

Cores thus arranged not only considerably ease the problem of operation but are also more readily accessible for inspection, cleaning and lubricating than those which have to pass through the main body of the mould blocks. Wear due to frictional rubbing between the core and its housing is also likely to be somewhat less in such arrangements.

Movable cores may be operated by means of attachment to a slidable core-holding plate or a sleeve which, in its turn, is actuated, either being arrested at a point throughout the movement of the mould block opening, the former member being permitted to continue its movement for a sufficient additional distance to effect operation of the core from the stationary mould block.

Cores which have to be located in the stationary member of the mould will, of course, have to be withdrawn from the completed moulding before the main mould blocks are parted and thus prior to ejection. These core members must, therefore, be operated in some effective manner either by separate auxiliary automatic mechanisms or manually by rotating a cam, moving a wedge piece, or depressing a simple lever, etc.

Generally though, such arrangements tend to lengthen the moulding cycle and correspondingly decrease the rate of output, and for this reason alone it is always advisable to locate all such cores in the movable mould block wherever possible, even though this may entail some additional machining and a more elaborate core-withdrawing mechanism. Operation and production are likely to be smoother and quicker.

Long, slender core members should be secured if possible to the main mould block, the movable one, that is, and well supported by extension sleeves where the wall of the block is not wide enough to impart sufficient bearing surface. In cases where such slender cores are located along the same axis as that of ejection it is often unwise to eject off them, as this imposes considerable strain on the ejectors, and, moreover, is very apt to cause serious deflection or permanent distortion to the long, slender cores. In all cases such cores should be withdrawn before ejection commences.

Another important practical point to observe in the withdrawal of movable cores is to arrange the mechanism in such a manner that there is a short dwell

period after the opening of the main mould blocks before cores commence to withdraw. This, in many cases, very considerably eases the strain on both mould mechanisms and the machine parts, and thus obviates very troublesome features of misalignment, errors, failure of mould blocks to close correctly, and difficulties in pulling cores out of the completed moulding.

It is nearly always inadvisable to undertake the coring of very deep holes from both ends of the moulded article, as it is in practice exceedingly difficult to maintain such core members in proper alignment with each other, which results in cross located portions of the hole. Then, again, normal working conditions of vibration, jar, etc., render most

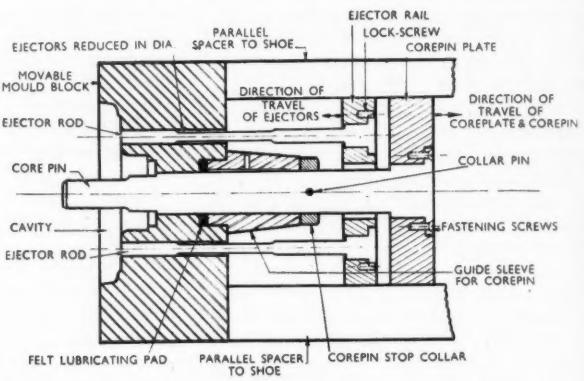


Fig. 6.

styles of core pin registration somewhat uncertain, and generally the finished hole would need final sizing and straightening after moulding.

Small-diametered or isolated cores set at any angle to the parting line of the mould blocks can be operated by a simple rack-and-pinion mechanism, so arranged to be performed either automatically and positively or manually by the operator. Manual operation is not recommended except in those cases where it is manifestly impossible to install automatic functioning of the cores, because any omission on the part of the operator to raise the core before starting the ejection of the moulded component might cause very serious damage to other moulded members, and so entail much labour and time on the part of the maintenance toolmaker.

Perhaps one of the simplest constructions likely to be encountered is that illustrated in Fig. 6, which shows a sectioned view of the movable mould block, together with all assembled arrangements incorporated thereon for operating the sliding core member employed to form the shaped bore of the component, as well as the sliding ejector pins, etc., needed for the removal of the finished article.

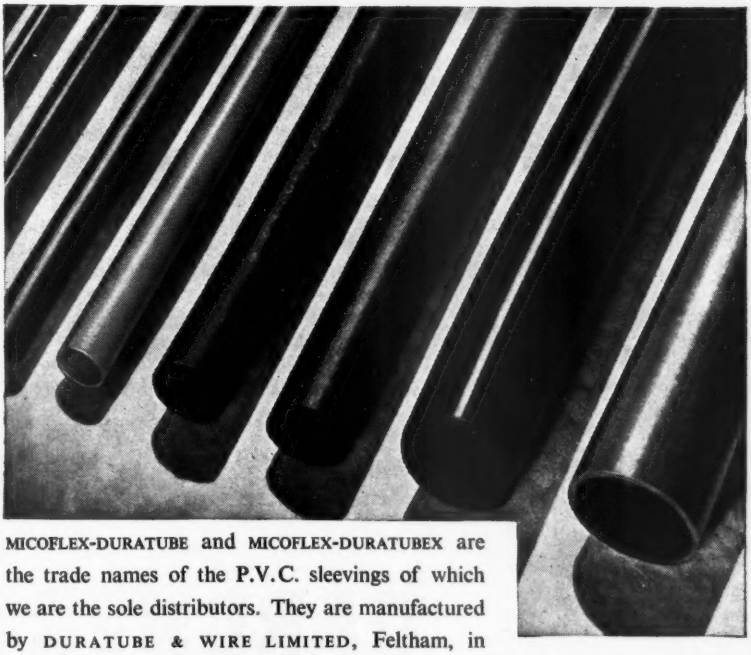
The major portion of the mould cavity is located in the movable block and the portion of the core situated within this cavity area is of two diameters so as to form a similar shaped hole in the moulded article.

In the first place it will be noticed that the sliding core pin is positioned and secured within a separate core-holding plate, this latter member being guided to travel freely between the parallel spacers interposed between the rear end face of the mould block and front of the mould shoe. These spacing plates are necessary in order to obtain the necessary width of opening between the mould block and its shoe to enable the core plate and ejector rail sufficient space in which to be operated.

The end of the core pin affixed to the

MICOFLEX-DURATUBE & MICOFLEX-DURATUBEX

P.V.C. EXTRUDED SLEEVINGS



MICOFLEX-DURATUBE and MICOFLEX-DURATUBEX are the trade names of the P.V.C. sleevings of which we are the sole distributors. They are manufactured by DURATUBE & WIRE LIMITED, Feltham, in various colours, in a complete range of sizes and thicknesses, and in various degrees of hardness ranging from SUPER FLEXIBLE to RIGID. Braided and reinforced types of sleevings (MICOFLEX-DURATUBEX), which comply with various Government Specifications, are made for special applications.

m and i

THE MICANITE & INSULATORS CO. LTD., EMPIRE WORKS, BLACKHORSE LANE, LONDON, E.17

Makers of MICANITE (Built-up Mica Insulation); Fabricated and Processed MICA; PAXOLIN (Synthetic-resin Laminated sheets, rods, tubes and cylinders); High-voltage Bushings and Terminals for indoor and outdoor use; Empire varnished Insulating Cloths and Tapes and all other forms of Electrical Insulation. Suppliers of Vulcanised Fibre Leatheroid, Presspahn, etc. Sole distributors of Micoflex-Duratube Sleevings (P.V.C.).

A GREAT STRIDE FORWARD !

A NEW standard in fast grinding has been set by the GARDNER latest High-Speed Attrition Mill. This revolutionary machine effects perfect reduction in far less time and at less operational cost. Built to GARDNER'S traditional high level of workmanship and material, it will run day in, day out, with that freedom from trouble that is a characteristic of all GARDNER machines. Write for full particulars.

GARDNER

HIGH SPEED ATTRITION GRINDING MILL

LONDON:
19, Gray's Inn Chambers,
20, High Holborn, W.C.1.
Telephone - Chancery 7347.

WM. GARDNER & SONS (Gloucester) LTD.,
BRISTOL ROAD, GLOUCESTER.
Telephone: Gloucester 2288 (3 lines). Telegrams: "Gardner, Gloucester."

core-holding plate is enlarged in diameter and made a tight press fit within the hole in the plate. Also it is provided with a flanged end housed in a shallow recess at the right-hand end of the hole in the core plate, a number of small vee-head screws then being passed through this flanged portion and screwed into tapped holes in the plate so as to prevent any endwise movement of the core independently of the holding plate.

The core passes through a clearance hole in the ejector pin rail, as shown, so that no interference is afforded to the independent movement of this latter member, which, of course, must be operated after the core pin has been withdrawn backwards out of the finished piece.

It will also be noted that the core pin slides horizontally in a plain guide hole in the movable block member, but in order to secure additional guidance this hole is extended by employing a hardened steel sleeve. This auxiliary is shouldered at the point of its fitment into the rear face of the mould block, this reduced portion being made a very tight press-in fit therein. If desired this sleeve could be fastened in by means of retaining screws or cross-pins, but for the sake of clearness these are omitted in the present illustration. This sleeve, it will be seen, is provided with oil grooves along the length of its bore, access for lubricant being made through a small oil hole provided. In order still further to ensure good lubricating qualities to this hardened sleeve and so to avoid stiff working or ultimate seizure of the core within the sleeve, a felt pad is inserted into the bottom of the recess in the mould block and the oil grooves made to pass clean out of the left-hand side of the bore, so as to feed oil into this felt pad, which thus becomes soaked and holds a considerable quantity of lubricant. The core pin passes through this pad as shown and at each stroke is wiped clean and lubricated at the same time. In the case of very long production runs it will be advisable to remove the sleeve when the mould is taken out of use, and renew this felt ring in readiness for the next production run.

In this construction means had to be provided for ensuring the correct return of the core pin and its holding plate, this being very simply accomplished by attaching a stop collar on to the core-pin shank, as shown. This collar bears against the right-hand end face of the extension guide sleeve. In other designs it will be possible to secure such stopping action by means of a shoulder on the core pin or a step on the parallel spacers between the mould block and its shoe.

The construction here illustrates the ejector rods used to push out the finished moulding from the block cavity. As will be observed, these are long and somewhat slender. Their endfaces come exactly level with the base wall of the cavity and are located on an unimportant surface. They slide in plain cylindrical holes located in the mould block, and are enlarged considerably, to about twice their working end diameter, in fact, at the point where they are attached to the ejector rail. This large head portion is made a tight press fit within the rail, and this latter is recessed to receive the flanged end of the pin. A small lock-screw is located half-way through the head and rail, as shown, to ensure that the pin shall not move backwards out of the rail.

In order to provide for more smooth working of these ejectors, they are reduced a matter of about .015 on the diameter for a portion of their length between the working end and rail, as is indicated. This will be found a very useful measure in the case of practically every type of ejector rod.

The operation of this mould construction is as follows:—First, the movable mould block is moved apart from the stationary block, bringing the finished moulding with it. At a certain portion the movement of the mould block is restrained whilst that of the core plate continues, thus pulling with it the core pin and so extracting it from the finished piece. Immediately this has been done the ejector rail begins to operate by

travelling towards the left, thereby causing the ejector pins to push the component out of the cavity. These movements are then automatically reversed in readiness for the next moulding cycle.

By arranging the core withdrawal and ejection in this manner, strain and distortion upon the moulded part are greatly minimized. In addition, the stress and possible injury likely to fall upon the slender ejectors is greatly reduced. With such a construction the maintenance needs should comprise largely a periodical inspection to detect signs of wear, especially on the core pin and the extension guide sleeve, lack of lubricant, alteration in position of the core when the mould blocks are closed, and, possibly, adjustment and tightening up of the check screws holding the core pin and ejectors in position.

Fig. 7 shows a partial sectional illustration of another very well-known method of core pin withdrawal which is very reliable in service.

The chief characteristics to be noticed in respect of this mould construction is that the core pin employed for coring the small diametered hole in the side of boss portion of moulding is carried in a special, movable slide member, which is actuated in such a manner as to effect the automatic withdrawal of the core pin from the mould cavity with each opening motion of the main mould blocks.

This design is widely used on a variety of core withdrawing mechanism, and generally the core slide, or block as it is sometimes termed, is arranged so as to operate at right-angles to the direction of main block opening or closing movement. More than one such core withdraw slide may be used provided the necessary pressure required for raising them and their core pins from the finished moulding does not impose too great an additional load upon the machine mechanism.

Usually such core pin withdraw slides are fitted into grooved or dovetailed shaped slots in the mould block, and either the movable or stationary blocks may be used for holding them. Customary practice is to house such slides, etc., in the movable block wherever possible, however.

Much mould maintenance attention may be spared if some care is bestowed upon the questions of design and methods of constructing such core slides and their fitting. Much will depend in this connection upon the number of core pins to be carried in a slide, the amount of draught, or taper, permissible on the sides of the cores, and the length of their draw. Where possible the slide should move perfectly freely and smoothly, but without side play or slackness, and preferably some means should be installed whereby wear between sides or slide and

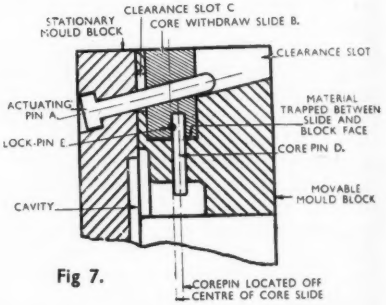


Fig 7.

its guiding slot may be adjusted quickly and positively.

In the case of heavy slide members, carrying a number of large core pins, and having to be moved through a considerable distance when effecting withdrawal of pins, there may be a danger that the additional load imposed on machine operating mechanism may prove too great for safety, resulting in strained tie rods, levers, or even sheared shackle-pins, etc. Not only might this arise but the degree of wear occurring on sides of slide or its slot may be rapid and extensive, hence to avoid this the slide should be fitted with specially hardened and removable slips, which members may be detached as wear occurs and replaced inexpensively with new pieces to restore the original good sliding fit.

The core slide shown in this instance in Fig. 7 is rectangular in shape and fits

within a suitably milled slot in the main movable block. This guide slot is not carried down so as to break into the mould cavity; instead, a very substantial wall is left, as will be seen. This is essential because if the slot should break through, difficulty will arise in effectively sealing off the portion of cavity, as well as securing the correct shape. If the supporting wall is left too thin there will be a risk of its being distorted as a result of the injection pressure during moulding.

As will be observed, the core pin is fastened into the bottom end of the withdraw slide B by means of the cross-pin E passing halfway through pin and slide. Operation of the slide is obtained by means of the fixed angularly disposed pin A which is parallel in length and cylindrical in cross-section. This actuating pin has an enlarged head at one end and is made a very tight press fit within the angular hole machined in the stationary mould block as shown. The head portion resides in a suitable counter-bored recess so as to lie slightly below the end face of block. A clearance slot C elongated in length is cut through the thin wall of the movable mould block immediately in front of the withdraw slide slot in order to allow free passage of the pin. At the opposite side of the slot in moving block clearance is afforded for the actuating pin as seen.

The actuating pin A should be well hardened and ground, whilst the portion surrounding the hole in withdraw slide should also be case-hardened, and the hole finally lapped so as to ensure a very smooth sliding action when pin is in contact.

The method of operation is very simple yet positive. After injection the movable block is operated by being pulled towards the right, thus causing the withdraw slide B to ride up the slanting pin A, so lifting the core pin D with it clear of the sides of the cavity and the moulded article.

This construction possesses several advantages as well as a number of drawbacks. It is positive, simple in operation, automatic and very effective if the angle of the actuating pin is not more than about 20 degrees from horizontal.

The drawbacks, however, are very appreciable and worthy of consideration by the maintenance toolmaker.

The actuating pin should be made of very ample dimensions, so as to preclude all possibility of its being deflected, as this would entail faulty location of the withdraw slide and its core pin. Then again the pin could be pushed back a short distance unless some means were provided for arresting this. Care would also have to be taken to ensure that no dirt, or material particles find their way into the very close space left between bottom of slide B and endface of guide slot when slide is in working position in readiness for the injection of a shot of material. Should this occur there would take place a gradual build-up until in time the slide may not reach the correct position, the actuating pin being bent upwards as a result, and the core pin inserted too short a distance into the cavity.

Furthermore, the method of securing the core pin into its withdrawal slide leaves much to be desired. If the pin works tightly within the hole through the wall of the main block, due, say, to a lack of lubricant, it may become so tight as to sever the pin E through the slide, thereby allowing the core pin to pull out.

Yet another fault lies in the lack of any provision for holding the withdraw slide B in its raised position whilst the finished moulding is being ejected, which, by the way, is performed by separate pins not here illustrated. After a short period of working it will be found that the slide would work very easily and immediately the actuating pin was withdrawn from the hole in the slide it would tend to fall down again. This would entail a slowing-up of production as the operator would have to raise the slide and hold it until engagement with pin A was again effected. Of course, in some instances it will be possible to arrange the amount of mould block opening so that the pin A never withdraws entirely from its slide, but usually as wide an opening

as possible is desired between stationary and moving blocks.

It will also be noted that the core pin D is located off the vertical centre line of the withdraw slide, which will mean in practice that there will be a certain tendency for the slide to tilt, especially if wear is allowed to arise in the fit of the actuating pin. Another disadvantage is the extremely thin wall of metal left on the parting-line face of the moving block to carry the clearance elongated slot C through which the pin A has to pass. This thin section may cause trouble due to distortion or twist, especially so should the slide ever become very tight in the guide slot.

Perhaps the chief obstacle to successful operation of this type of core withdrawal mechanism lies in the absence of any lock or checking-action on the withdraw slide. In the case of a moulding requiring a large core pin the pressure on end of pin during the period of injection is likely to be very considerable, and if imposed upon a pin of fairly large area may cause a slight upward lift of both core and its slide, even to the extent of bending the actuating pin.

The writer would recommend the fitment of some means additional to that of the operating pin for ensuring that any such upthrust caused during injection shall be effectively negatived.

A very much more satisfactory design is shown in Fig. 8, which again is a partial sectioned view of the same mould incorporating, of course, several features for improving both its operation, accuracy and freedom from operating snags of the kind already noted in association with the previously discussed type of construction.

The actuating pin A is made more substantial at the point of its fitment into the stationary mould block, and a lock screw F is employed to prevent it pushing back when mould blocks are being closed and the withdraw slide is pulled down. This screw passes through the enlarged head and into a tapped hole in the bottom of recessed portion of the block as indicated.

The core slide B is engaged by the actuating pin A in same manner as before, but is fitted slightly differently into the movable mould block.

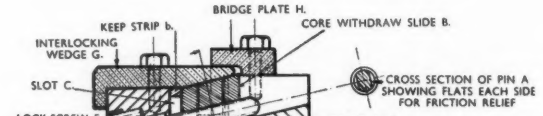


Fig. 8.

A slot is machined clean across the parting-line face of this block member to a depth greater than the thickness of the slide B, and a steel keep strip b is fitted onto the remaining portion of the slot in order to bring the block to the requisite distance, and at the same time allow free sliding movement to the slide. This strip piece is hardened and ground perfectly flat and to correct thickness and then screwed and doweled in place. It also carries the elongated slot C through which pin A passes with sufficient clearance in all its working positions.

The advantage of this method of construction is that the machining for housing the slide is greatly facilitated, it being possible to use a substantial slab milling cutter instead of a slender end-milling one as would be necessary with the type of guide slot shown in the construction at

Fig. 7. The keep strip is also easily and inexpensively made and thus renders renewals needed to take up any wear a very simple matter. In the case of a mould having to produce a very large quantity of mouldings a spare strip could usefully be made at the same time as the rest of the mould components.

The actuating pin is also provided with two flats along its length normally in engagement with the withdraw slide as indicated in the cross-sectional cut shown to the right hand. The purpose of these flats, which should be machined diametrically opposite to each other and for a depth sufficient to bring them to a width about two-thirds the full diameter of the pin, is to reduce frictional contact with the hole on the slide and thus improve the wearing capacities of both.

The core pin itself is located on the exact vertical centre line of the withdraw slide, and is provided with a headed portion at the end secured to the slide. This latter member is drilled and counterbored as shown to receive the core pin, and the major portion of the counterbored part of the hole is threaded to take a locking-screw. This latter member is shown in broken line and its duty is to bear down forcibly on the head of core pin D to prevent it from moving backwards within the slide.

There are several advantages to be gained from this construction. In the first place the core pin is positively locked to the slide, but in such a manner as will ensure its ready removal when required for replacement, or alteration of setting. Secondly, should it be necessary to adjust the pin farther into the mould cavity so as to core a deeper hole, it may quickly be removed, and a slight amount of stock removed from the underside of its head portion corresponding to the distance to be altered. On the other hand, should it become necessary to raise the core pin a slight amount so as to form a shallower hole, then it will be a very easy matter for the maintenance toolmaker to remove the core and insert an appropriately thin shim or washer under the head to raise up the core the required amount.

It will also be observed that the mould block wall between end of withdraw slide guide slot and cavity is drilled and recessed to take the hardened steel bush M. This member is provided with a flanged end which locates in the recess formed around top of the hole. Two small tapped holes are machined through this flanged portion for extraction purposes. The bush does not pass into the cavity, stopping short by a small amount as shown.

Such a provision will be found exceedingly useful and of much assistance in reducing wear and ensuing errors. As will be appreciated, should any wear occur between the withdraw slide and its slot, each time engagement is made with the actuating pin the slide may suffer a certain amount of rocking action, which, in turn, will be transmitted to the core pin D, thus tending to bind this member in the guide hole in mould block wall. Cases have been noted where such a pin has actually seized due to this action plus lack of lubricant. The specially hard and lapped bush M will serve to arrest such tendencies, as well as permit very rapid correction should wear eventually arise.

To avoid trapping surplus material, dirt accumulations and the like between bottom end of withdraw slide and bottom of its guide slot, when the former is in its lowest position, an ample clearance space is provided as shown.

In this construction means are also provided for maintaining the withdraw slide B in its raised position, even though the actuating pin may be completely withdrawn from contact with the slide, as when the two mould blocks are opened very wide apart. This is simply accomplished by means of a hardened ball J located in a horizontal hole drilled from the rear face of the movable block. Backing this ball is a stiff compression spring K, this in turn being held by the stop screw L screwed into the end of the hole in the block. The right-hand side face of the slide is provided with two dimples, one coinciding with the lowest position occupied by the slide, the other

with its highest position when lifted by the pin A. Thus the ball will locate in one of the dimples and hold the slide, which would then be correctly located in readiness for re-engagement by pin A.

This mould was required for rather heavy work, that is, the pressure on core pin D was found sufficient to raise the slide a slight amount. In order to obviate this the construction was usefully amended in the following manner: To the top edge of the stationary mould block was fitted a steel block. This was made wide enough to span both mould block and the portion of movable block containing the withdraw slide B. This portion of the block G was made wedge shape, as shown, all the taper being formed on its underside, whilst the top edge was left perfectly flat and horizontal. This wedge block G was stepped at its left-hand side so as to pass down the vertical side of the mould block, thereby securing a heel upon this latter member.

To the top edge of the movable mould block was fitted, by means of set screws, a steel bridge plate, as at H. This was suitably gapped out in the centre to allow the tapered end portion of wedge G to pass underneath, but in such a way as to avoid any clearance other than required for normal working. These two members were situated on their respective mould blocks in such a way as to cause the interlocking wedge G to pass underneath the bridge plate H, and the tapered underside of G to be bearing down on top of the withdraw slide B when the mould blocks are in the closed or injecting position. Thus any upthrust caused by the incoming material will be resisted effectively by the interlock provided with the interaction of these two members. Opening and closing movements of the main blocks are not interfered with in any way, and ready access is afforded the operator for applying lubricant to the parts when the movable block is withdrawn into the open position.

This design, of course, may be adapted very simply to be incorporated upon numerous forms of core slide mechanisms where it is found desirable to install additional safety means for retaining the slide in its correct position throughout pressure injection stage of the production cycle. It is a construction of extreme simplicity and there is little to go wrong. All the parts are hardened and smooth polished on the contact points to reduce unnecessary friction.

Where convenient, means should be provided for the lubrication of the actuating pin and its hole in the withdraw slide, as this point is likely to prove one of the most fruitful of operating troubles. Regular inspections should be made of the following points for detecting signs of wear, lack of lubricant, dirt accumulations or slackness:—The actuating pin should be periodically checked for the degree of tightness of lock with the stationary mould block. Its surface should be maintained well polished and smooth, as a roughened one will add considerably to the operation of the withdraw slide. This slide should also be inspected fairly often to ensure its smooth working within the guides. It should occasionally be removed even though no trouble has been reported in order to clear out adhering particles of dirt, etc., which will be found to have gained access to the clearance space between it and the bottom of the guide slot. The core pin D should also be tested for lock, straightness, and smooth surface, as well as closeness of fit within its guide bush M. Care should also be taken to prevent the inclined top end of the withdraw slide from getting bruised, or roughened, as this would cause more difficult engagement with the interlocking wedge and its bridge, which might in some circumstances prevent the complete closure of the main mould blocks. The retaining or keep strip, should also have careful attention from time to time to ensure its tight fit, and to see that no undesirable distortion has occurred.

With such maintenance attention and inspection this construction will give continual good service, and is a design which can therefore be recommended on this account.

Methods of Attaching Cores to Their Core Plates

Before leaving the subject of cores it will be advisable to consider in some detail the advantages or otherwise of the numerous methods employed by toolmakers for affixing core pins into the core withdrawing plate or slide. Very many simple and effective methods are used, but some of them are open to various objections when viewed from the angle of the maintenance engineer. In practice they are often the source of considerable worry by reason of the many minor troubles, and, in some instances, breakdowns which they occasion. Many times a very simple fastening device such as this may create troubles requiring the frequent skilled attentions of the maintenance toolmaker for corrections, etc. Production, too, is very often stopped and worry and cost increased.

In the various illustrations shown in Fig. 9, a number of these common forms of core-pin fastening are depicted. That at A is perhaps one of the commonest, widely adopted no doubt on account of its extreme simplicity and ease of manufacture as well as very low cost. It consists of simply driving a cross pin through both core pin and its plate, as shown in the sectional view. The core pin is left perfectly plain in diameter and is made a tight fit within the plate. The lock pin is drilled at right angles and passes with half its diameter in each member.

This form of fastening often causes trouble by reason of the lock pin becoming sheared off due to unusual drag upon the core-pin shank. Another drawback is that it quickly allows the core pin to work loose due to the push and pull movements imposed upon the core during mould operation. In the case of cores having very light duty to perform this might serve quite well, especially if the lock pin were made of some tough material such as chrome nickel steel, unhardened. But for heavier work it is not to be recommended in spite of its inexpensiveness.

Another equally widely used form is shown at B. The core pin is reduced in diameter for a distance slightly greater than the width of the core plate or slide, etc., and made a tight fit within the hole in this latter member. Sufficient overhang is then left to prevent the end of the pin being upset by riveting to secure the pin in position. Here, again, is a design that requires using with some caution, because the act of riveting may cause a misalignment of the position of the core, especially if the thickness of the core plate is small. Then no means for adjusting the core-pin projection beyond the face of the plate is afforded by this method. As this feature is always a very useful one the construction is accordingly limited. Where a large

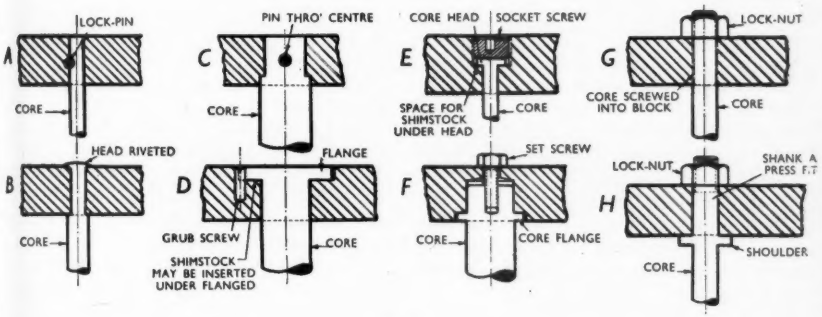


Fig. 9.

number of more or less same size core pins have to be located in one block, then it may be worth while using this method. Another difficulty with its use will relate to the ability to extract this core without trouble. The writer could instance numerous occasions where a great deal of irritation and time was expended upon just such operations as withdrawal of worn core pins fitted in this manner.

Sectioned cut C illustrates another well-used method. This comprises a shouldered core pin, fitting with its reduced end into the core plate, and secured from endwise movement by the dowel or lock pin inserted crosswise through it and the plate. This pin is located to pass clean through the diameter of the core pin instead of at the side, as at A.

This is quite a good design, and in the case of large diametered core pins it is possible to get a substantial lock pin through the members. Unfortunately, no simple means for core-pin adjustment is afforded by this type.

The next type, shown at D, is to be preferred, even though it involves rather more labour and time to install. The core pin is headed at one end, and the shank made a tight press fit within the hole in the plate. The head or flange is made to seat within a recess formed in the top of the plate around the hole, and the flange should be large enough in diameter to allow for a grub screw being threaded into a tapped hole drilled half-way in the flange and half-way in the plate as shown.

This method of fastening ensures that the core pin can be easily removed without inflicting damage either to plate or pin. It also enables endwise adjustments to be made whereby the amount of projection of the core may be altered, this being performed by the simple expedient of inserting shim-stock underneath the head when requiring to retract the core, or by removing a shaving or two of material from the underside face of its flange if an advancement of core is desired. In addition, the flanged head will take the pull-out pressure on the core, as it is being withdrawn from the finished moulding, there thus being no danger of the core pulling out of the plate. The grub screw plus tightness of core fit in plate will be sufficient to withstand the much less push pressure when the core is being returned in readiness for another injection stroke.

A very good design is illustrated at E; this shows the core plate fitted with a headed core pin, as in the case of D, but the pin head is sunk well into the plate, this latter being deeply counterbored as shown. A portion of this counterbore is internally threaded to receive a socket-head check screw, which is used for binding down on to the head of the core. The shank of the core is made a press-in fit within the plate as before. This type allows for easy adjustment of the core, and very quick withdrawal from the plate.

Illustration F shows yet another good design, which is well worth adopting in the case of large-diametered core pins upon which considerable pressures are to fall. The core is fitted into a hole in the plate as shown, the shouldered portion being housed in a recess on underside of the plate. The core is drilled and tapped centrally up the end within the plate, and a set screw is used to draw back the core against the shoulder.

This construction permits a very powerful retention of the core pin, whilst allowing for its very easy removal or adjustment, as desired. Where this latter step arises shim-stock may be inserted between the flange and the bottom of the recess in the plate, or the shoulder may be thinned to suit. Thrust and pulling pressures imposed upon the core are equally provided for with this design, which will be found to afford lengthy and trouble-free service even in most severe working conditions.

View G shows yet another design commonly encountered. This consists of the core pin with a threaded shank being threaded into a tapped hole in the core plate and locked by means of a standard lock-nut on the other side of the plate, as

shown. This is a very simple form, but open to a number of snags. First, a very accurate location of the core cannot be ensured by relying solely upon the fit between the two threaded portions. Then the lock-nut is apt to jar loose by the vibration set up during working conditions.

The last illustration, indicated at H, is actually an improvement upon the type depicted at G. The core is threaded to receive a lock-nut, but is not threaded into the core plate, its shank being made a press fit therein. To give endwise location the core is provided with a shoulder as shown, and is clamped up by the nut against this shoulder. This is quite a useful type, and for small light-duty cores will give very satisfactory service.

(To be continued)

"CASCO" GLUES

UNTIL recently spiral, convolute and straight tube winders have used dextrine and animal glues in their operations almost exclusively and this has been largely due to the unrivalled " tack " properties which are inherent in them. These dextrine and animal glues are, however, completely water soluble and form reversible gels in the glue line which soften and lose their adhesive strength under the influence of moisture and humid conditions; they are also very prone to development of fungoid growth.

The problem of preparing a waterproof paper tube by winding is one which has been given a great deal of attention, but experimental data has shown that a waterproof glue line is no criterion of the finished container's resistance to moisture owing to water penetrating the chipboard itself and causing the paper to soften and disintegrate.

The production of a completely waterproof and water-repellent chipboard by impregnation with bitumen opened up an entirely new field, and it was realized that this material bonded with a waterproof glue would give a container resistant to extreme weathering.

Leicester, Lovell and Co., Ltd., of Stroud, Glos, who have carried out much research work in this field, have published a bulletin on the subject and on the " Casco-resin " and casein glues that they have developed for this branch of industry.

" Casco-resin " for Spiral Tube Winding

" Casco-resin " is a milky white liquid urea-formaldehyde condensation product, stabilized and prepared so that it can be readily applied to bitumen-impregnated board at normal temperature by the usual glue-bath method. " Casco-resin " can be used for tube winding by either the combined or separate application methods.

" Casco-resin " should be placed in the glue baths without any addition or alteration and the spread adjusted by means of the doctor blade to give an even film arriving at the mandrel in a slightly tacky state. Details are also given as to the points at which " Casco " K-12 hardener, a colour liquid, should be added. A convenient method is to pass the paper over felt-covered rollers dipping into the K-12; the tension of the paper over the rollers should be adjusted to give a uniform wetting but not an excess. It is important to note that the hardener must be applied to the paper after the resin, and never before. The mandrel should be heated preferably by steam to a temperature of 200-212 degrees F., and a feeding speed used which ensures that the tube takes 3 secs. passing over the heated surface.

Straight Tube Winding

Straight tube winding may be carried out in a similar manner to spiral winding, using the separate application technique and K-12 hardener, but as the mandrels of straight winding machines do not readily lend themselves to heating, a combined application method has been evolved using " Casco " M-8 powder hardener.

" Casco " M-8 hardener is in the form of a blue-tinted powder and is specially buffered for paper work in order to avoid excess acidity. The hardener should be thoroughly mixed into the resin.

The mixture should be placed in the glue bath and the spread adjusted to give a thin even application.

As " Casco-resin " relies on its thermo-setting properties as distinct from tack, the final lap seam of the straight wound tube must be made to hold by rubbing a heated surface over it in order to give the necessary heat and pressure; an electric iron set at 200 degrees F. will perform this rapidly.

Resinoids and Other Plastics as Film Formers

By B. J. BRAJNIKOFF,
Consulting Electrical Engineer

XXIV.—Synthetic Coatings Based on Acetylene (Contd.)

OF special interest to the technology of the film-forming hydrocarbons are the methods for the conversion of ethylene into ethyl alcohol, in which field notable advances have been achieved in Russsia by Vansheidt.[377] He succeeded in working out the methods that give good yields of alcohol; Vansheidt has also successfully investigated the process of hydrolysis of diethyl ether.[378]

The ethylene hydrocarbons are utilized for numerous and diverse syntheses. For example, by means of dehydrogenation it is possible to pass from butylene to divinyl, as developed by Professor Balandin. The same method converts ethyl-benzol into styrene.

Of particular importance is the polymerization of ethylene hydrocarbons. Depending on the operating conditions, it is possible to obtain the products of different degrees of polymerization. By polymerizing ethylene hydrocarbons under high pressures they form polymers which yield excellent films, threads, etc. Much of this work has been carried out by the Institute of High Pressure Reactions in Leningrad.

The study of more unsaturated hydrocarbons containing several double bonds has been marked by very significant results in the sphere of both theory and practice. In this respect, of great interest are the divinyl and allene types. The efforts of Russian chemists have been rewarded by development of the methods for the production of divinyl, isoprene and chloroprene, which are directly related to the synthetic rubber-like plastics of the chloroprene, divinyl and "Sovprene" varieties.

Lebedeff's original process for the manufacture of divinyl, and its polymerization into rubber-like products, resulted in the creation in Russia during the past ten years of the gigantic industry of divinyl rubber. Furthermore, the various by-products of the Lebedeff method have found the manifold applications to the synthesis of valuable substances, such as primary and complex ethers, oxides, haloid derivatives, etc.

A considerable amount of work in Russia has been devoted to the study of hydrocarbons having several multiple bonds, in addition to the aforesaid divinyl type, also to compounds with the more closely situated double bonds (allenes), and the hydrocarbons having double bonds more widely interspaced than those of divinyl.

Reactions with Acetylene

Of no less importance than these is acetylene and its derivatives.

Their use in the chemical industry during the past few decades has been expanded on an enormous scale, and in this connection the classical work of Favorsky in the field of acetylene hydrocarbons has acquired particular significance. Reactions discovered by Favorsky and his school in the sphere of acetylene and diethylene hydrocarbons have recently found a wide recognition and are now utilized in industrial practice.

Apart from polyvinyl acetate obtainable from acetylene and occupying now a prominent place in the range of the latest plastic products, great strides have recently been made by the Plastics Research Institute in Leningrad, where under the able direction of Professor Uschakoff and his collaborators there have begun, on the Favorsky's initiative, a comprehensive development of vinyl

ethers, derived by heating acetylene under pressure in alcohols in presence of alkali. These ethers in the polymerized state have already secured a number of valuable technical applications, and their scope is rapidly growing. These interesting compounds are being extensively studied by Favorsky and Shostakovsky.[379]

Vinyl Ethers

The working out of the problem of the vinyl ethers has been the natural sequel and outcome from the previous investigations of Favorsky.

In 1888, Favorsky[380] in studying the isomerization of mono-substituted acetylene hydrocarbons under the influence of an alkali, examined the action of an alcohol solution of potassium hydroxide on methylacetylene with the aim of obtaining an allene. However, the heating of the reaction mixture in a sealed test tube for 12 hrs. at from 170 degrees to 180 degrees C. gave not an anticipated allene, $CH_2 = C = CH_2$, but an unsaturated simple ether with boiling point from 62 degrees to 63 degrees C.—ethylisopropenyl ether. Its formation is expressed by the following scheme:

$$CH_3 - C \equiv CH + C_2H_5OH \longrightarrow CH_3 - \underset{\displaystyle OC_2H_5}{\overset{\displaystyle |}{C}} = CH_2$$

This ether was found to be a fairly stable compound. On heating in a sealed tube up to 100 degrees, 170 degrees, or even up to 200 degrees C., it displayed not the slightest trace of decomposition.

Nevertheless, further work in the above direction had been interrupted, partly due to the fact that, in Favorsky's own words, "the syntheses of other mono-substituted acetylenes of respective ethers could not be realized even at from 130 degrees to 140 degrees C. on account of their easy decomposition, i.e., at a temperature level approximately the minimum, at which the reaction between a mono-substituted acetylene and alcoholic alkali is still possible." The other reason, however, had been the absence of special high-pressure plant.

None the less, this problem has again been tackled by Favorsky, and recently has been successfully solved by him. It should be remarked that, although laboratory tchnique of our time has made great strides compared with that of the past century, particularly in regard to high-pressure apparatus, the question of handling acetylene under pressure remained until recent years still not sufficiently clear on account of absence of the experimental data.

As is known, compressed acetylene is capable of explosive spontaneous decomposition. Unfortunately, the available literature, with the exception of the work by Peters,[382] contains no special investigations indicating the causes and precise conditions which are liable to lead to acetylene explosions. This investigator has found that, in some instances, acetylene did not explode on heating under pressure even up to 200 degrees C. On the other hand, there have been cases on record when acetylene explosion occurred even at 50 degrees C. Thus, in this respect, there are still no definite indications, and the phenomena of a spontaneous acetylene decomposition has to be considered as a matter of chance.

In industrial practice of chemical reactions under pressure, therefore, acetylene is diluted with an inert gas, such as nitrogen, carbon dioxide or light hydrocarbons. The work with such a diluted acetylene is then free from hazards.

The carrying out of the reaction between acetylene and alcohol in the conditions analogous to the formation of the above-described ethylisopropenyl ether was, of course, based on the application of compressed acetylene. The experiments could have been conducted only in a high-pressure autoclave, inasmuch as the reaction mixture had to be heated up to between 150 degrees and 170 degrees C. The use in this case of acetylene diluted with nitrogen or other gas presented a technical difficulty and would unquestionably reduce the effect of the reaction.

The problem has been solved by Favorsky and Shostakovsky[383] by means

of applying an original method of dilution, in which acetylene and alcohol are readily condensed, forming the unsaturated ether according to the equation:—

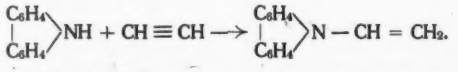
$$CH_3 - CH_2OH + CH \equiv CH \longrightarrow CH_3 - CH_2 - O - CH = CH_2.$$

This ether may be regarded as the derivative of unsaturated vinyl alcohol, $CH_2 = CHOH$, which does not exist in the free state. As is known, vinyl alcohol is the enol form of acetaldehyde, and, on being released in the free state, is immediately regrouped into acetaldehyde. The ether so obtained is, consequently, a representative of a homologous series of primary alkylvinyl ethers. Hence, ethylisopropenyl ether synthesized by Favorsky in his first works may be regarded as a homologue of the ethylvinyl ether.

The carrying out of a similar experiment with the methyl alcohol even at 120 degrees C. has yielded vinylmethyl ether. Subsequently, vinylpropyl, vinylisobutyl, vinylisoamyl, and other ethers were obtained. The reaction with glycol, under analogous conditions, gave the divinyl ether of ethyleneglycol, and with glycerine the trivinyl ether. The extension of studies in this direction has enabled investigators to apply this reaction also to the components of an aromatic series. Thus, with phenol, under identical conditions, it yielded the vinylphenyl ether, and with cresol the corresponding cresyl ether. Finally, of late it has been established that it is possible to substitute the vinyl group for hydrogen not only in the hydroxyl group of alcohols and phenols, but also the mobile hydrogen of other groups, for example, of the group NH. Thus, with diphenylamine, the acetylene gives a vinyl derivative—vinyldiphenylamine:—

$$(C_6H_5)_2\,NH + CH \equiv CH \longrightarrow (C_6H_5)_2\,N - CH = CH_2,$$

with the carbazol—the vinylcarbazol:—



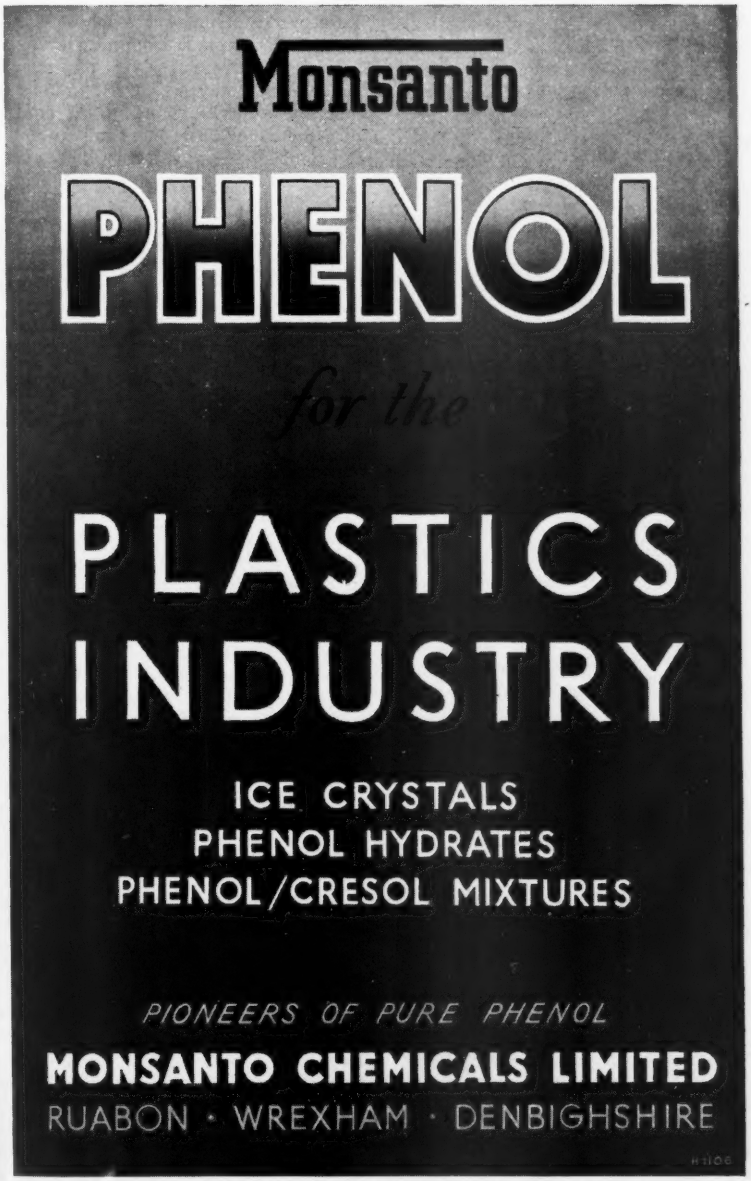
In consequence of this it is already possible to speak of a new reaction, namely, that of "vinylizing," consisting of obtaining vinyl combinations by the action of acetylene under pressure upon alcohols, phenols, amino-derivatives and other compounds having a replaceable hydrogen in the molecule.

It is to be noted that, hitherto, the simple vinyl ethers have been but little known. The methods of their production recorded in the technical literature are based on the reaction of splitting off, with alkali, of the elements of a haloidhydrogen acid from the haloid-substituted simple ethers. In this way, for instance, Chalmers[384] obtained certain primary vinyl ethers.

Since monobrom-derivatives of ethers are but little available and are costly compounds, it follows that vinyl ethers produced from them could not find their way from the laboratory to the industrial field. It is true that, commencing from 1930, there appeared published records of patent specifications relating to the production of the vinyl ethers by the German concern I.G. Farbenindustrie. These patents repeat Favorsky's work of 1888, and are based on acetylene diluted with nitrogen. It is easily seen that such a dilution appreciably diminishes the reaction velocity, requires a costly plant equipment of bulky size, and a periodical stopping of the process for the removal of nitrogen.

The Favorsky-Shostakovsky Method

In the production method as developed by Favorsky and Shostakovsky, the reaction progresses with a very high velocity, wherein, inasmuch as the acetylene can be continually pumped in, the process may be carried on right up to the point of the complete expenditure of the alcohol, that is, it affords an effective


Monsanto
PHENOL
for the
PLASTICS
INDUSTRY
ICE CRYSTALS
PHENOL HYDRATES
PHENOL/CRESOL MIXTURES
PIONEERS OF PURE PHENOL
MONSANTO CHEMICALS LIMITED
RUABON · WREXHAM · DENBIGHSHIRE

means of obtaining 100 per cent. yield calculated on the weight of alcohol. A further advantage of the process attaches to the fact that there are no losses of acetylene in side reactions.

The exceptional ease of production and the valuable properties of vinyl ethers, as will be seen from the subsequent text, prompted the Government of the U.S.S.R. to issue at the beginning of 1940 a special decree for the introduction of simple vinyl ethers into industry without delay. In fulfilment of the above Government measure, the necessary experimental plant for semi-scale manufacture of primary vinyl ethers has been constructed. The experience obtained even from its month's working has fully confirmed all the calculated data of the designs, and has demonstrated that there are no objections to the adoption of this method on a large industrial scale.

The simple vinyl ethers are mobile liquids having a characteristic ether odour. They can be distilled without decomposition and are, generally, fairly stable compounds capable of withstanding without change heating up to temperatures considerably higher than their boiling points. They can be kept in storage without suffering modification for a great length of time. The physical constants of certain vinyl ethers are summarized in Table 1.

Table 1.—Physical Constants of Simple Vinyl Ethers.

Name of the ether	Boiling temperature, °C.	D_t^{20}	Refractive index n_D^{20}
Vinylmethyl ether ..	9– 10	—	—
Vinylethyl ether ..	35– 36	0.759	1.3856
Vinylpropyl ether ..	63– 64	0.768	1.3902
Vinylisopropyl ether	53– 54	0.756	1.3840
Vinyl-n-butyl ether ..	92– 93	0.780	1.4015
Vinylisobutyl ether ..	80– 81	0.768	1.3962
Vinylisoarnyl ether ..	109–110	0.783	1.4070
Vinylphenyl ether ..	155–156	0.9770	1.5520
Divinyl ether of ethyleneglycol ..	126–126	0.914	1.4340
Trivinyl ether of glycerine	164–165	1.033	1.4380

As may be noted from the above Table, the vinyl ethers have boiling points appreciably lower than corresponding alcohols and, consequently, can easily be separated from the latter by distillation. But in comparison with the respective simple ethers they boil at somewhat higher temperature levels. In other words, the introduction into the molecule of a double or triple bond raises the boiling point of the product, as illustrated in Table 2.

Table 2.—Physical Constants of Saturated and Unsaturated Simple Ethers.

Name of the ether	Boiling temperature, °C.	D_t^{20}
Diethyl ether	34.5	0.714
Vinylethyl ether	35.5	0.759
Divinyl ether	39	0.773
Ethylpropyl	61.4	0.732
Vinylpropyl ether.. ..	63–64	0.768
Ethylallyl ether	67.6	0.765
Ethylpropargyl ether ..	80	0.833

One of the most remarkable chemical properties of alkylvinyl ethers is their ability to hydrolyze. Favorsky's early work on ethylisoprophenyl ether had already established that this ether is hydrolizable by water in the presence of an acid with the formation of alcohol and acetone. The examination in this respect of the alkylvinyl ethers showed that they are easily hydrolized by one per cent. or two per cent. sulphuric acid into the alcohol and acetaldehyde according to the equation, shown at the head of the following page.

Thus the carrying out of the reaction of " vinylizing " and subsequent hydrolysis of the alkylvinyl ether enables us to perform the hydration of acetylene into acetaldehyde. As is known, the hydration of acetylene into acetaldehyde in industry is now being conducted to a great extent by Kutcheroff's method in the presence of mercury salts as catalysts. This production is practised on a particularly large scale in the U.S.A.[385] However, for various reasons, this mode of production has not been adopted in Russia.

The manufacture of acetaldehyde by means of hydrolysis of vinyl ethers proceeds very easily, is completely free from

$$CH_2 = CH - O - CH_2 - CH_3 + H_2O \longrightarrow CH_3 - CH_2OH + CH_2 = CHOH$$

$$CH_2 = CHOH \longrightarrow CH_3 - C\begin{matrix}O\\H\end{matrix}.$$

Hydrolysis of alkylvinyl ethers into alcohol and aldehyde.

the application of mercury salts, and gives immediately a readily separable mixture of alcohol and aldehyde, wherein after the fractional distillation the alcohol is returned to the reaction vessel. The aldehyde so obtained can be treated by oxidation into acetic acid or by reduction —into ethyl alcohol.

It is perfectly obvious that the new method of the acetaldehyde production through the hydrolysis of vinyl ethers is bound to secure an appropriate place in the chemical industry.

Another no less valuable property of the simple vinyl ethers is their ability for easy polymerization.[386] Depending on the catalytic agent and the conditions of the process, they yield polymers of various degrees of composition. They have already proved to be of special value in many branches of industry, being utilized to great advantage, for example, for bonding the laminæ of safety glass, in the production of plastics either alone, or by co-polymerization with different substances, as additional substituents to the natural or synthetic rubbers, as powerful adhesives for rubber, as sealing and impregnating compounds, protective anti-corrosive coating compositions, and a great number of other applications.

Favorsky's proposal to use vinyl ethers for the production of acetaldehyde on the basis of hydrolysis of these ethers is, clearly, of the utmost importance, as it renders this aldehyde available to industry in great quantities at low cost, and avoids the objectionable features of the old Kutcheroff's process necessitating the catalytic action of mercury salts. A cheap acetaldehyde constitutes a vitally important initial raw material for the plastics industry, as, for instance, in the manufacture of polyvinylacetals, in the production of acetic acid, which is the basic component in the making of acetyl-cellulose and acetate silk.

Another interesting method for utilizing the Favorsky reaction is its use in the synthesis of acetylene alcohols by condensation of acetylene and its homologues with ketones in the presence of alkali. This reaction served as a basis for the recent development in Russia for producing synthetic isoprene rubber and a vast range of film-forming agents.

Development of Favorsky's Process

In Favorsky's process for synthesizing isoprene there are required acetylene, acetone and potassium hydroxide. The acetone may be produced, besides the usual methods, from acetylene and carbon dioxide by means of a catalytic reaction, which has lately been worked out in the Soviet Union, thus opening up the way for synthesis of rubber-like plastics on the basis of the calcium carbide and the lime.

On the other hand, if Favorsky's reaction for obtaining acetylene alcohols be applied to vinylacetylene, it gives a great range of valuable and interesting film-forming compounds, adhesives and cements. A detailed investigation of alcohols—the products of condensation of vinylacetylene with ketones in presence of caustic potash—carried out by the pupil of Favorsky, Professor Nazaroff,[387] has led to the development of an extensive series of the diverse alcohols and their ethers, which in the polymerized state proved themselves to be excellent film-formers, tenacious adhesives, capable of replacing Canadian balsam in optical devices, for the preparation of soluble lacquers and kindred compositions.

Favorsky's reaction for the synthesis of acetylene alcohols found of late its useful modification in the works of Kazarian,[388] at the Synthetic Rubber Factory in Erevan, Transcaucasia, which utilizes carbide of calcium directly.

Another notable development in the utilization of acetylene has recently been evolved by the Zelinsky's Laboratories in Moscow and the Leningrad Institute of Applied Chemistry, which has led to the production on an industrial scale of a new type chlor-containing rubberlike material "Sovprene," an outstandingly superior elastomer on an acetylene base.

Acetylene, in the presence of catalysts, condenses into vinylacetylene, which is subsequently transformed into chloroprene through the addition to vinylacetylene of hydrogen chloride. The chloroprene is easily polymerizable into high-grade rubberlike plastics.

Extensions Resulting from "Sovprene"

The manufacture of "Sovprene" gave rise to an extensive series of researches on the chemistry of vinylacetylene and its derivatives. Some of these investigations deserve to be mentioned if even only briefly.

The derivatives of vinylacetylene and polymers of chloroprene have been studied by Klebansky.[389] Favorskaya and Rotenberg have succeeded in converting vinylacetylene into styrene.

The fruitful possibilities in the sphere of diverse applications of the acetylene are illustrated by the work of Zelinsky on the acetylene condensation into benzene and other hydrocarbons of the aromatic series, in the presence of the activated carbon, by heating at a high temperature, which thus affords the effective means for producing a wide range of aromatic derivatives.

Zelinsky, with his collaborators, Kazansky, Platé and others, also studied the contact cyclization of paraffin hydrocarbons.[390]

The rich fund of information accumulated in organic chemistry, which seemed to be of purely theoretical nature, has now found its due field of ever-growing practical utilization. This trend, to a large extent, has been accelerated by the phenomenal development of processes of the radical treatment of petroleum for motor fuel by means of catalytic cracking, destructive hydrogenation, polymerization of the cracked gases, alkylization, etc., which were, during the past few decades, instrumental in providing a number of theoretical and synthetic problems, many of which, after their solution, constitute the routine operations in the present-day chemical engineering.

Petroleum hydrocarbons not only contain compounds of the open chain type, but also the cyclic ones, particularly for such petroleum products derived from the Caucasus. As has been stated earlier, Markovniff and his students succeeded a long time ago in isolating naphthenes from petroleum, and studied them in detail. Of late, the most interesting works on naphthenes and naphthenic acids belong to the school of Zelinsky, who, since 1895, devoted his attention to the investigation of naphthenes' synthesis and petroleum components. A great amount of work has been expended for the study of the course of the dehydration reaction of alcohols, the catalytic dehydrogenation into aldehydes and ketones, catalytic transformations into simple and complex ethers, the compounds of the aromatic and heterocyclic series, and other combinations.[391]

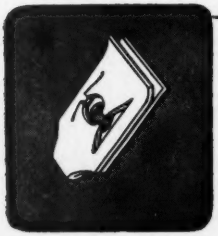
REFERENCES

(377) *Vansheidt; J. Applied Chem., VII,* 1461-3, 1934. *J. Gen. Chem., VII,* 470, 1937. **(378)** *Vansheidt; J. Gen. Chem., III,* 329, 1933. **(379)** *Favorsky and Shostakovsky; Bulletins Academy Sciences, U.S.S.R., No.* 2, 181, 1940. **(380)** *Favorsky; J. Russian Chem. Soc.,* 20, 518, 1888. **(381)** *Favorsky;* "*Selected Papers,*" 46' *Moscow,* 1940. **(382)** *Peters; Industrial Org. Chem.* 2, 560, 1936. **(383)** *Favorsky and Shostakovsky; Chem. Progress, X, No.* 6, 1941. **(384)** *Chalmers; Canad. J. Research, VII,* 464, 1932. **(385)** *Kazarnovsky; Industrial Org. Chem., VI,* 4-5, 1940. **(386)** *Favorsky; Bulletins Acad. Sc., U.S.S.R.* 183, 1940. "*Selected Papers,*" 505, *Moscow,* 1940. **(387)** *Nazaroff; Bulletins Acad. Sc., U.S.S.R. XXIV,* 1, 24-66, 1942. **(388)** *Kazarian; J. Gen. Chem., VII,* 956, 1937. **(389)** *Klebansky; J. Gen. Chem., VII,* 1294, 1937. **(390)** *Zelinsky and Associates; J. Gen. Chem. VIII,* 366, 1938. *Reports, Acad. Sc. U.S.S.R. No.* 27, 608, 164, 1940. **(391)** *Journal of General Chemistry, VII,* 1026, 1306, 1937.

(To be continued)

Strength through SPIRE

A Spire assembly is a tight assembly—and nobody need trouble to send us any jokes about the word 'tight'. It's no joke fumbling and fitting washers and nuts on to invisible bolts. It's no joke knowing that the things will probably shake loose anyway inside a few weeks. If you use a Spire fixing these worries disappear along with the nuts and washers. There are a few thousand firms making motor vehicles and radio sets and hundreds of other products who know that for light assembly Spire means strength. If you don't know but would care to find out, send us your drawings or the parts of an assembly. We'll see what Spire can do and let you have the answer in a couple of weeks—more or less.



—THAT'S Fixed THAT!—

Here's a Spire Nut of the U type that is doing noble work for electrical manufacturers concerned with cable assembly. The NU 1381 replaces the normal nut and washer used for holding the cable clips on perforated cable trays. The U fixing makes such blind assembly easy. The Spire Nut slips into position gripping the tray and there it is, ready — no more fumbling about with a nut that you can't see.

Spire

*** A BETTER way of fixing**

Simmonds Aerocessories Limited · Great West Road · London · A Company of the Simmonds Group

6

Thermoplastic—"O.K." 11th Century

THERE SEEMS to be some argument as to who made the first plastic, but there is at least one natural plastic, sealing wax, which has been used for many centuries to *settle* arguments. The common wax seal, noted in Chinese commentaries as early as 544 B.C., has marked the official O.K. on countless historic documents from earliest times. Important, yes . . . but only by 'agreement between parties', and not to be compared as a practical asset with the modern man-made synthetics, with their 'prefabricated' molecules and endless variety of form and colour.

The rapid development of new plastic materials, calling for new methods of applying heat and pressure, has of course demanded new fuels with new standards of accuracy and control undreamed of by the early pioneers. Wherever exact temperature is needed, at low capital and operating costs, Gas, the modern fuel, is playing its part . . . not only directly, in the warming and mixing process, in the heating of preforms, and in the actual moulding, curing and stoving . . . but indirectly, in gas-fired boilers for the maintenance of constant steam pressure without stoking. And why? Because Gas offers speedy, reliable heat on tap, wherever and whenever it is wanted . . . accurate, measureable heat capable of easy thermostatic control . . . clean, economical heat . . . simple, cheap in maintenance and with ample flexibility for progressive development in an ultra-progressive modern industry.

THE TWENTIETH-CENTURY INDUSTRIALIST KNOWS THE VALUE OF GAS

Gas equipment is only available for priority work, but industrialists planning for the post-war period can benefit from wartime experience and achievement.

BRITISH COMMERCIAL GAS ASSOCIATION
1 GROSVENOR PLACE . S.W.1

The New Post-war Material

The Wartime uses of JIXONITE cannot be told yet, but its post-war applications are already apparent.

JIXONITE is a sandwich material consisting of a closed cellular expanded plastic core with plywood, plastic or light metal alloy skins. It is very light and strong, with low thermal and sound conductivity; non-water absorbent; vermin and bacteria proof, and non-warping.

There are a hundred-and-one uses for JIXONITE, in flat sheets or in preformed curved panels; thicknesses from ¼" upwards. For coach and vehicle bodies, deck houses, marine craft, caravans, lightweight furniture and showroom fixtures. Aircraft fuselages and components. Refrigerators and all kinds of insulating panels and partitions. JIXONITE can also be used for ventilating duct work that forms an integral part of architectural design. Further details gladly sent on request.

JIXONITE

JICWOOD LTD., WEYBRIDGE, SURREY
Telephone: Weybridge 3376. Telegrams: Jicwood, Weybridge
LONDON: Grosvenor Gardens House, Westminster, S.W.1
J.12

Pioneers! in MOULDS for MODERN PLASTICS

also Press Tools, Jigs and Gauges.

BARBER & DUFFY LTD
214/222, Cardigan Road, LEEDS,
Telephone: LEEDS 52033

Member of the Gauge and Toolmakers' Association.

TRIPLE U BRAND
PATENT No. 322957
PATENT LEATHER
PACKINGS
Specially Designed
FOR PLASTIC PRESSES
JOHN TALENT & CO. LTD
ASHWORTH STREET WORKS, MANCHESTER 9

Stepping stones to Electrical Safety!

PERMALI

LAMINATED SYNTHETIC RESIN IMPREGNATED

•

Tensile Strength 24,000 lbs. per square inch.

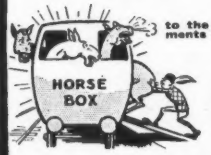
THE NEW INSULATION CO. LTD.
GLOUCESTER ENGLAND

TENAPLAS
Electrical Insulation
TENAPLAS LTD., 7 PARK LANE, LONDON, W.1

COURTAULDS
LIMITED
CELLULOSE ACETATE SHEETING AND FILM

Foleshill Road, Coventry Tel.: Coventry 88771

PACKING SCREWS



to the specific requirements of our customers

Makers of all types of repetition products from the bar in all metals

M·C·L and REPETITION LTD.
Pool Lane · Langley · Birmingham.

GEORGE COHEN, SONS & CO., LTD.
Engineers & Machinery Merchants
Established 1834

REQUIRE TO PURCHASE
good Surplus PLANT & MACHINERY—either single items or Complete Works. Please inform our nearest Area Office :—
GLASGOW : Cogan Street, Pollokshaws; NEWCASTLE-ON-TYNE : Trafalgar House, Collingwood Street; MANCHESTER : Cobden Street, Pendleton; SHEFFIELD : Coborn Works, Tinsley; BIRMINGHAM : 191, Corporation Street; BATH : Lower Bristol Road; SWANSEA : Prince of Wales Dock; SOUTHAMPTON : Princes Street, Northam; REDRUTH : 25, Albany Road;
or Chief Offices and Depot :—
Southern : WOOD LANE, LONDON, W.12; Northern : STANNINGLEY, nr. LEEDS.

TYNE TRUCK & TROLLEY CO. LTD.
Hand Trucks of every Description

66-68 NORTHUMBERLAND ST.
NEWCASTLE UPON TYNE.

PITMAN CORRESPONDENCE COLLEGE
(Sir Isaac Pitman & Sons, Ltd.),
167, Southampton Row, London, W.C.1,
offers a course of lessons on
PLASTICS
The Course is being prepared by a team of experts and has the approval of The Institute of Plastics Industry.
For particulars apply Principal :
R. W. Holland, O.B.E., M.A., M.Sc., LL.D.

AGENCIES WANTED

A WELL-KNOWN FIRM of selling agents, having excellent London and Provincial connections, with available West-end showroom and office space, is desirous of contacting manufacturer anxious to establish his present and post-war sales. Box No. 3764, c/o "PLASTICS." 89/x942

OFFICES, BUSINESSES, PREMISES, ETC.

SMALL PLASTICS FACTORY for Sale in London. Principals only. Box No. 3884, c/o "PLASTICS." 89/5

SITUATIONS VACANT

BUTTON TURNERS REQUIRED to turn and drill plain Erinoid Blanks from 22 to 54 lines. Regular work. Material will be delivered. Please contact: EXPRESS BUTTON SUPPLY, LTD., 616a, Finchley Road, N.W.11. Tel.: SPE. 0245. 89/4

LARGE MANUFACTURERS of plastics require one or two first-class chemists for research and development in the manufacture and use of the phenolic group synthetic plastics. Works located North of England. Full particulars, age, experience and salary to Box No. 3886, c/o "PLASTICS." 91/3412

PLASTICS. Works Manager required, to take complete control of factory. Must have good technical knowledge of plastics and costings. Good organiser. Excellent prospects. Write, giving full particulars of experience and salary required, to Box No. 3654, c/o "PLASTICS." 89/1

PROMINENT PLASTICS CONCERN require services of an experienced person to develop department for the spraying and colouring of plastic articles. Good opening for progressive type of person capable of training young female labour. London area. Reply to Box No. 3655, c/o "PLASTICS." 89/2

TECHNICAL/COMMERCIAL Representative required, with experience of plastics materials, particularly moulding powders and synthetic resins. Permanent post for right man with old-established company. Write, with full details of experience, salary required, etc., to Box No. 3652, c/o "PLASTICS." 89/3307

WANTED, young man with up-to-date chemical and chemical engineering qualifications to undertake development work in application of plastics to industrial uses from the laboratory to works processes. Preference will be given to applicants with experience in this class of work. Box No. 3887, c/o "PLASTICS." 89/7

SITUATIONS WANTED

PLASTIC MOULD DESIGNER, 7 years' experience in compression, transfer and injection moulds, desires to do freelance mould design and detailing, could devote a probable 20-hour week. Box No. 3848, c/o "PLASTICS." 89/x1277

WANTED

ACETATE AND NITRATE sheet off-cuts and scrap urgently wanted for work of National importance. We pay top prices. LLOYD'S, 72, Bridge Street, Christchurch, Hants. 'Phone: Christchurch 504. zzz/45

ATTENTION! Have you any idle pre-war compression moulds? We are interested either through rental or purchase, in compression moulds formerly employed in a substantial production of pre-war, non-military articles. Please give all particulars in replying to Box No. 3653, c/o "PLASTICS." 90/3306

CAPACITY wanted for Bakelite Mouldings, size 5¼" x 3¼" x 1". Box No. 3656, c/o "PLASTICS." 89/3

ERINOID BLANKS WANTED, all sizes and colours. Apply: EXPRESS BUTTON SUPPLY, LTD., 616, Finchley Road, N.W.11. SPE. 0245. 89/9

INJECTION MOULDING capacity required. Priority contracts. Follow-up orders. Continuing after war. Box No. 3650, c/o "PLASTICS." 89/3306

WANTED, contracts suitable for 6 Bakelite Presses of 25-50 tons. Box No. 3885, c/o "PLASTICS." 89/6

MISCELLANEOUS

AVAILABLE—large quantity of cork in various forms, suitable as grinding material, filler, insulation or other manufacturing purposes. Samples and particulars from Box 5048, G.T.C., 21-41, Wellington Road, London, N.W.8. 89/10

CONSULT KAY'S upon plastic adhesive problems. Our research laboratories can help you. KAY BROTHERS LTD., Kayborough, Reddish, Stockport. 89/3173

FACTORY TIME RECORDERS. Service rental. 'Phone, Vigilant 4731. TIME RECORDER, SUPPLY & MAINTENANCE CO., 28, Mayfield Rd., Sutton, Surrey. zzz/41

HYDRAULIC PUMP, delivering approximately 50 gallons per minute at 700-1,000 lb per square inch, complete with motor, on fabricated steel bedplate for pump and motor, together with "V" belt drive and special unloading device so that the pump continues to by-pass under no pressure when the maximum has been obtained. Box No. 3539, c/o "PLASTICS." 89/x261

MONOMARK service. Permanent London address. Letters redirected, 5/- p.a. Write BM/MONO76, W.C.1. 92/3171

MOULDS and industrial mouldings. Large capacity available, quick delivery all types. STEELE, 121, Hamlet Gardens, W.6. Telephone : Riverside 5349. 89/x1196

MOULDS.—Grained embossing plates and rollers. J. MARTIN & SONS, LTD., Ardwick, Manchester, 12. 98/3170

NEW ELECTRIC MOTORS, 1½ h.p. to 10 h.p., 400/440 volts, 3-phase, 50 cycles and 230 volts, single phase. Immediate delivery for essential purposes. Also many other items for industrial needs. Send for Catalogue K506. THE STERLING PUMP CO., LTD., London Road, Spalding. 90/3305

POST-WAR PRODUCTS, Scientific Market Research will indicate most successful openings for new products or potential markets. Surveys at moderate fees can be undertaken for one or two new clients. Write Box No. 3684, c/o "PLASTICS." 91/x594

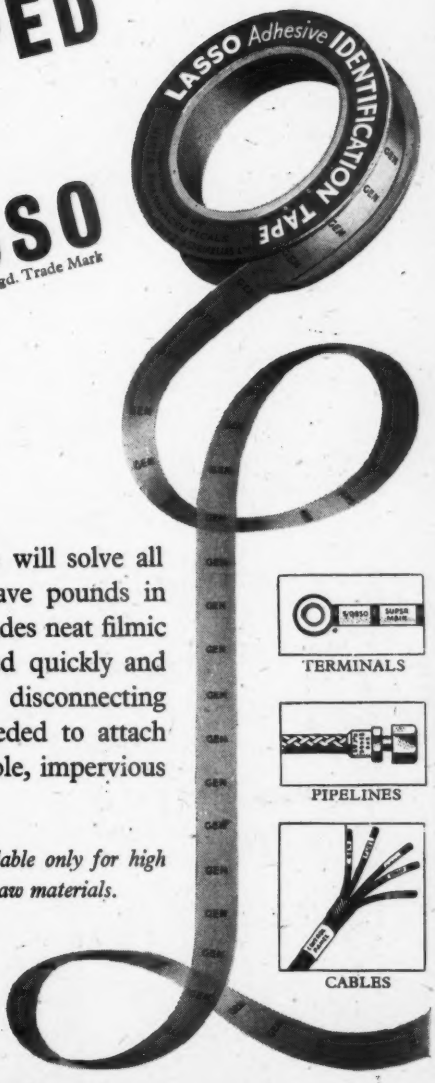
PULVERISING & GRINDING undertaken for the trade, advice given and research undertaken at our experimental stations. Three fully equipped factories. DOHM LTD., 167, Victoria Street, London, S.W.1. 95/2855

WE DESIRE to get in touch with patentees of processes for producing plastics, utilising as basic raw materials, the oil, cake, or hull of groundnuts (peanuts) and other East Indian produce, with a view to acquiring Rights for certain countries abroad. Write Box No. 3688, c/o "PLASTICS." 89/8

Printed in England and Published Monthly by the Proprietors, TEMPLE PRESS LTD., BOWLING GREEN LANE, LONDON, E.C.1.

Get it TAPED with LASSO

Regd. Trade Mark



Lasso Identification Tape will solve all your marking problems and save pounds in time and labour. Lasso provides neat filmic markers which can be applied quickly and easily at any point without disconnecting the leads. No tools are needed to attach it, and it is durable and legible, impervious to heat and fluids.

Supplies of Lasso Tape are available only for high priority work owing to restrictions on raw materials.

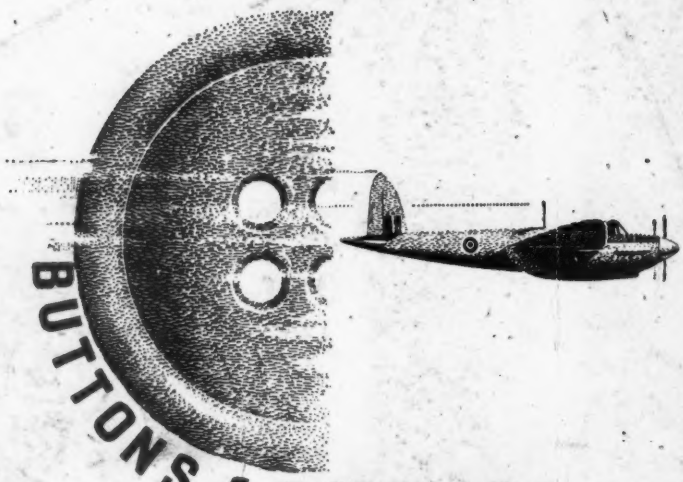
TERMINALS

PIPELINES

CABLES

CABLE ASSEMBLIES LTD. (Subsidiary of Herts Pharmaceuticals Ltd.), BESSEMER ROAD, WELWYN GARDEN CITY.

OCTOBER, 1944. Vol. VIII. No. 89 **Plastics** ONE SHILLING & SIXPENCE

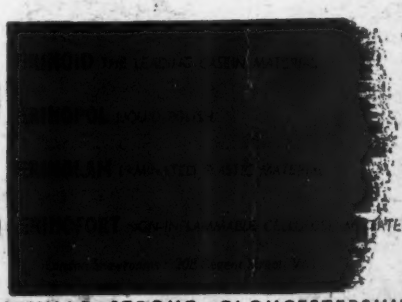


BUTTONS & BOMBERS . . .

PARTS for the bombers that are cracking-up Germany. Buttons for the pants of the men who make them and the men who fly them. Buttons and bombers—we know quite a lot about both. It's our job to, for we 'know about plastics' and make a range of first-rate plastics and plastic materials that are well to the fore in war-time production.

What have we up our capacious sleeve for after the war? . . . Plastic materials for buttons (in an amazing variety of colours), plastic materials for an amazing variety of products and a comprehensive knowledge of plastics applications at the service of all who care to drop us a line at Stroud or at our London Office. If you have a problem involving the use of plastics we can help you to solve it.

ERINOID PLASTICS



ERINOID LIMITED, LIGHTPILL MILLS, STROUD, GLOUCESTERSHIRE